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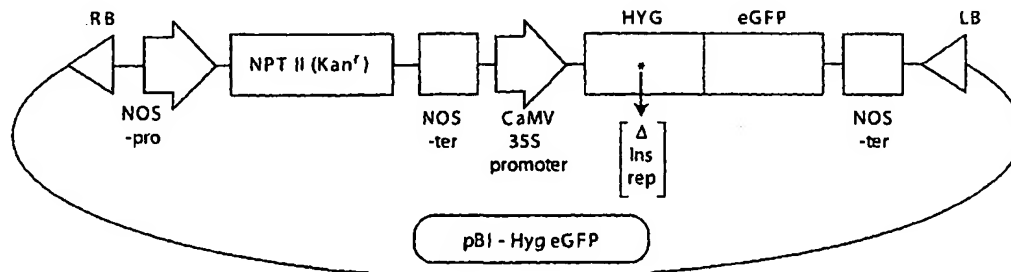
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(54) Title: TARGETED CHROMOSOMAL GENOMIC ALTERATIONS IN PLANTS USING MODIFIED SINGLE STRANDED OLIGONUCLEOTIDES



(57) Abstract: Presented are methods and compositions for targeted chromosomal genomic alterations with modified single-stranded oligonucleotides. The oligonucleotides of the invention have modified nuclease-resistant termini comprising LNA, phosphorothioate linkages or 2'-O-Me base analogues or combinations of such modifications.



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TARGETED CHROMOSOMAL GENOMIC ALTERATIONS IN PLANTS USING MODIFIED SINGLE STRANDED OLIGONUCLEOTIDES

Field Of The Invention

The technical field of the invention is oligonucleotide-directed repair or alteration of plant genetic information using novel chemically modified oligonucleotides.

Background Of The Invention

A number of methods have been developed specifically to alter the genomic information of plants. These methods generally include the use of vectors such as, for example, T-DNA, carrying nucleic acid sequences encoding partial or complete portions of a particular protein which is expressed in a cell or tissue to effect the alteration. The expression of the particular protein then results in the desired phenotype. See, for example, United States Patent 4,459,355 which describes a method for transforming plants with a DNA vector and United States Patent 5,188,642 which describes cloning or expression vectors containing a transgenic DNA sequence which when expressed in plants confers resistance to the herbicide glyphosate. The use of such transgene-containing vectors adds one or more exogenous copies of a gene in a usually random fashion at one or more integration sites of the plant's genome at some variable frequency. The introduced gene may be foreign or may be derived from the host plant. Any gene which was originally present in the genome, which may be, for example, a normal allelic variant, mutated, defective, and/or functional copy of the introduced gene, is retained in the genome of the host plant.

These methods of gene alteration are problematic in that complications which can compromise the vigor, productivity, yield, etc. of the plant may result. One such problem is that insertion of exogenous nucleic acid at random location(s) in the genome can have deleterious effects. The random nature of this insertion and/or the use of exogenous promoters can also cause the timing, location or strength of expression of the introduced transgene to be inappropriate or unpredictable. Another problem with such systems includes the addition of unnecessary and unwanted genetic material to the genome of the recipient, including, for example, T-DNA ends or other vector remnants, exogenous control sequences required to allow production of the transgene protein, which control sequences may be

exogenous or native to the host plant and/or the transgene, and reporter genes or resistance markers. Such remnants and added sequences may have presently unrecognized consequences, for example, involving genetic rearrangements of the recipient genomes. In addition, concerns have been raised with consumption, especially by humans, of plants containing such exogenous genetic material.

5 More recently, simpler systems involving poly- or oligo- nucleotides have been described for use in the alteration of genomic DNA. These chimeric RNA-DNA oligonucleotides, requiring contiguous RNA and DNA bases in a double-stranded molecule folded by complementarity into a double hairpin conformation, have been shown to effect single basepair or frameshift alterations, for example, for mutation or repair of plant, animal or fungal genomes. See, for example, WO 99/07865 and U.S. Patent
10 5,565,350. In the chimeric RNA-DNA oligonucleotide, an uninterrupted stretch of DNA bases within the molecule is required for sequence alteration of the targeted genome while the obligate RNA residues are involved in complex stability. Due to the length, backbone composition, and structural configuration of these chimeric RNA-DNA molecules, they are expensive to synthesize and difficult to purify. Moreover, if the RNA-containing strand of the chimeric RNA-DNA oligonucleotide is designed so as to direct gene
15 alteration, a series of mutagenic reactions resulting in nonspecific base alteration can result. Such a result reduces the utility of such a molecule in methods designed for targeted gene alteration.

Alternatively, other oligo- or poly- nucleotides have been used which require a triplex forming, usually polypurine or polypyrimidine, structural domain which binds to a DNA helical duplex through Hoogsteen interactions between the major groove of the DNA duplex and the oligonucleotide.
20 Such oligonucleotides may have an additional DNA reactive moiety, such as psoralen, covalently linked to the oligonucleotide. These reactive moieties function as effective intercalation agents, stabilize the formation of a triplex and can be mutagenic. Such agents may be required in order to stabilize the triplex forming domain of the oligonucleotide with the DNA double helix if the Hoogsteen interactions from the oligonucleotide/target base composition are insufficient. See, e.g., U.S. Patent 5,422,251. The utility of
25 these oligonucleotides for directing targeted gene alteration is compromised by a high frequency of nonspecific base changes.

In more recent work, the domain for altering a genome is linked or tethered to the triplex forming domain of the bi-functional oligonucleotide, adding an additional linking or tethering functional domain to the oligonucleotide. See, e.g., Culver et al., Nature Biotechnology 17: 989-93 (1999). Such
30 chimeric or triplex forming molecules have distinct structural requirements for each of the different domains of the complete poly- or oligo-nucleotide in order to effect the desired genomic alteration in either episomal or chromosomal targets.

Other genes, e.g. CFTR, have been targeted by homologous recombination using duplex fragments having several hundred basepairs. See, e.g., Kunzelmann et al., Gene Ther. 3:859-867 (1996). Similar efforts to target genes by homologous recombination in plants using large fragments of DNA had some success. See Kempin et al., Nature 389:802-803 (1997). However, the efficiency and reproducibility of the published homologous recombination approach in plants has severely limited the widespread use of this method.

Earlier experiments to mutagenize an antibiotic resistance indicator gene by homologous recombination used an unmodified DNA oligonucleotide rather than larger fragments of DNA, wherein the oligonucleotide had no functional domains other than a region of complementary sequence to the target. See Campbell et al., New Biologist 1: 223-227 (1989). These experiments required large concentrations of the oligonucleotide, exhibited a very low frequency of episomal modification of a targeted exogenous plasmid gene not normally found in the cell and have not been reproduced. However, as shown in examples herein, we have observed that an unmodified DNA oligonucleotide can convert a base at low frequency which is detectable using the assay systems described herein.

Oligonucleotides designed for use in the targeted alteration of genetic information are significantly different from oligonucleotides designed for antisense approaches. For example, antisense oligonucleotides are perfectly complementary to and bind an mRNA strand in order to modify expression of a targeted mRNA and are used at high concentration. As a consequence, they are unable to produce a gene conversion event by either mutagenesis or repair of a defect in the chromosomal DNA of a host genome. Furthermore, the backbone chemical composition used in most oligonucleotides designed for use in antisense approaches renders them inactive as substrates for homologous pairing or mismatch repair enzymes and the high concentrations of oligonucleotide required for antisense applications can be toxic with some types of nucleotide modifications. In addition, antisense oligonucleotides must be complementary to the mRNA and therefore, may not be complementary to the other DNA strand or to genomic sequences that span the junction between intron sequence and exon sequence.

Artificial chromosomes can be useful for the screening purposes identified herein. These molecules are man-made linear or circular DNA molecules constructed from essential cis-acting DNA sequence elements that are responsible for the proper replication and partitioning of natural chromosomes (Murray et al., 1983). The essential elements are: (1) Autonomous Replication Sequences (ARS), (2) Centromeres, and (3) Telomeres.

Yeast artificial chromosomes (YACs) allow large segments of genomic DNA to be cloned and modified (Burke et al., Science 236:806; Peterson et al., Trends Genet. 13:61 (1997); Choi, et al., Nat.

Genet., 4:117-223 (1993), Davies, et al., Biotechnology 11:911-914 (1993), Matsuura, et al., Hum. Mol. Genet., 5:451-459 (1996), Peterson et al., Proc. Natl. Acad. Sci., 93:6605-6609 (1996); and Schedl, et al., Cell, 86:71-82 (1996)). Other vectors also have been developed for the cloning of large segments of genomic DNA, including cosmids, and bacteriophage P1 (Sternberg et al., Proc. Natl. Acad. Sci. U.S.A., 87:103-107 (1990)). YACs have certain advantages over these alternative large capacity cloning vectors (Burke et al., Science, 236:806-812 (1987)). The maximum insert size is 35-30 kb for cosmids, and 100 kb for bacteriophage P1, both of which are much smaller than the maximal insert size for a YAC.

An alternative to YACs are cloning systems based on the *E. coli* fertility factor that have been developed to construct large genomic DNA insert libraries. They are bacterial artificial chromosomes (BACs) and P-1 derived artificial chromosomes (PACs) (Mejia et al., Genome Res. 7:179-186 (1997); Shizuya et al., Proc. Natl. Acad. Sci. 89:8794-8797 (1992); Ioannou et al., Nat. Genet., 6:84-89 (1994); Hosoda et al., Nucleic Acids Res. 18:3863 (1990)). BACs are based on the *E. coli* fertility plasmid (F factor); and PACs are based on the bacteriophage P1. These vectors propagate at a very low copy number (1-2 per cell) enabling genomic inserts up to 300 kb in size to be stably maintained in recombination deficient hosts. The PACs and BACs are circular DNA molecules that are readily isolated from the host genomic background by classical alkaline lysis (Birnboim et al., Nucleic Acids Res. 7:1513-1523 (1979)). In addition, BACs have been developed for transformation of plants with high-molecular weight DNA using the T-DNA system (Hamilton, Gene 24:107-116 (1997); Frary & Hamilton, Transgenic Res. 10: 121-132 (2001)).

A need exists for simple, inexpensive oligonucleotides capable of producing targeted alteration of genetic material such as those described herein as well as methods to identify optimal oligonucleotides that accurately and efficiently alter target DNA.

Summary Of The Invention

Novel, modified single-stranded nucleic acid molecules that direct gene alteration in plants are identified and the efficiency of alteration is analyzed both *in vitro* using a cell-free extract assay and *in vivo* using a yeast system and a plant system. The alteration in an oligonucleotide of the invention may comprise an insertion, deletion, substitution, as well as any combination of these. Site specific alteration of DNA is not only useful for studying function of proteins *in vivo*, but it is also useful for creating plants with desired phenotypes, including, for example, environmental stress tolerance, improved nutritional value, herbicide resistance, disease resistance, modified oil production, modified starch production, and altered floral morphology including selective sterility. As described herein,

oligonucleotides of the invention target directed specific gene alterations in genomic double-stranded DNA in cells. The target genomic DNA can be nuclear chromosomal DNA as well as plastid or mitochondrial chromosomal DNA. The target DNA can also be a transgene present in the plant cell, including; for example, a previously introduced T-DNA. For screening purposes, the target plant DNA can also be extrachromosomal DNA present in plant or non-plant cells in various forms including, e.g., mammalian artificial chromosomes (MACs), PACs from P-1 vectors, yeast artificial chromosomes (YACs), bacterial artificial chromosomes (BACs), plant artificial chromosomes (PLACs), as well as episomal DNA, including episomal DNA from an exogenous source such as a plasmid or recombinant vector. Many of these artificial chromosome constructs containing plant DNA can be obtained from a variety of sources, including, e.g., the Arabidopsis Biological Resource Center (ABRC) at the Ohio State University, and the Rice Genome Research Program at the MAFF DNA bank in Ibaraki, Japan. The target DNA may be transcriptionally silent or active. In a preferred embodiment, the target DNA to be altered is the non-transcribed strand of a genomic DNA duplex. In a more preferred embodiment, the target DNA to be altered is the non-transcribed strand of a transcribed gene of a genomic DNA duplex.

The low efficiency of targeted gene alteration obtained using unmodified DNA oligonucleotides is believed to be largely the result of degradation by nucleases present in the reaction mixture or the target cell. Although different modifications are known to have different effects on the nuclease resistance of oligonucleotides or stability of duplexes formed by such oligonucleotides (see, e.g., Koshkin et al., J. Am. Chem. Soc., 120:13252-3), we have found that it is not possible to predict which of any particular known modification would be most useful for any given alteration event, including for the construction of gene alteration oligonucleotides, because of the interaction of different as yet unidentified proteins during the gene alteration event. Herein, a variety of nucleic acid analogs have been developed that increase the nuclease resistance of oligonucleotides that contain them, including, e.g., nucleotides containing phosphorothioate linkages or 2'-O-methyl analogs. We recently discovered that single-stranded DNA oligonucleotides modified to contain 2'-O-methyl RNA nucleotides or phosphorothioate linkages can enable specific alteration of genetic information at a higher level than either unmodified single-stranded DNA or a chimeric RNA/DNA molecule. See, for example, copending applications United States application no. 60/208,538, United States application no. 60/244,989, United States application no. 09/818,875, international application no. PCT/US01/09761 and Gamper et al., Nucleic Acids Research 28: 4332-4339 (2000), the disclosures of which are incorporated herein in their entirety by reference. We also found that additional nucleic acid analogs which increase the nuclease resistance of oligonucleotides that contain them, including, e.g., "locked nucleic acids" or "LNAs", xylo-

LNAs and L-ribo-LNAs; see, for example, Wengel & Nielsen, WO 99/14226; Wengel, WO 00/56748; Wengel, WO 00/66604; and Jakobsen & Koshkin, WO 01/25478 also allow specific targeted alteration of genetic information.

5 The assay allows for determining the optimum length of the oligonucleotide, optimum sequence of the oligonucleotide, optimum position of the mismatched base or bases, optimum chemical modification or modifications, optimum strand targeted for identifying and selecting the most efficient oligonucleotide for a particular gene alteration event by comparing to a control oligonucleotide. Control oligonucleotides may include a chimeric RNA-DNA double hairpin oligonucleotide directing the same gene alteration event, an oligonucleotide that matches its target completely, an oligonucleotide in which all
10 linkages are phosphorothiolated, an oligonucleotide fully substituted with 2'-O-methyl analogs or an RNA oligonucleotide. Such control oligonucleotides either fail to direct a targeted alteration or do so at a lower efficiency as compared to the oligonucleotides of the invention. The assay further allows for determining the optimum position of a gene alteration event within an oligonucleotide, optimum concentration of the selected oligonucleotide for maximum alteration efficiency by systematically testing a range of
15 concentrations, as well as optimization of either the source of cell extract by testing different plants or strains, or testing cells derived from different plants or strains, or plant cell lines. Using a series of single-stranded oligonucleotides, comprising all RNA or DNA residues and various mixtures of the two, several new structures are identified as viable molecules in nucleotide conversion to direct or repair a genomic mutagenic event. When extracts from mammalian, plant and fungal cells are used and are
20 analyzed using a genetic readout assay in bacteria, single-stranded oligonucleotides having one of several modifications are found to be more active than a control RNA-DNA double hairpin chimera structure when evaluated using an *in vitro* gene repair assay. Similar results are also observed *in vivo* using yeast, mammalian and plant cells. Molecules containing various lengths of modified bases were found to possess greater activity than unmodified single-stranded DNA molecules.

25 Detailed Description Of The Invention

The present invention provides oligonucleotides having chemically modified, nuclease resistant residues, preferably at or near the termini of the oligonucleotides, and methods for their identification and use in targeted alteration of plant genetic material, including gene mutation, targeted gene repair and gene knockout. The oligonucleotides are preferably used for mismatch repair or
30 alteration by changing at least one nucleic acid base, or for frameshift repair or alteration by addition or deletion of at least one nucleic acid base. The oligonucleotides of the invention direct any such alteration,

including gene correction, gene repair or gene mutation and can be used, for example, to introduce a polymorphism or haplotype or to eliminate ("knockout") a particular protein activity. For example, gene alterations that knockout a particular protein activity can be obtained using oligonucleotides designed to convert a codon in the coding region of the protein to a stop codon, thus prematurely terminating translation of the protein. Oligonucleotides that introduce stop codons in the open-reading-frame of the protein are one embodiment of the invention. Generally, oligonucleotides that introduce stop codons early in the open-reading-frame of the protein are preferred. If the open-reading-frame contains more than one methionine, oligonucleotides that introduce stop codons after the second methionine are preferred. Additionally, if the gene exhibits alternative splice sites, oligonucleotides that introduce stop codons in exons after the alternative splice site are preferred. The following table provides examples of codons that can be converted to stop codons by altering a single oligonucleotide. A skilled artisan could readily identify other codons that can be converted to stop codons by altering one, two or three of the base pairs in a given codon. Similarly, a skilled artisan could readily identify codons that can be converted to stop codons by a frameshift mutations that inserts or deletes one or two base pairs in the open-reading-frame. It is also understood that more than one stop codon can be generated in a single open-reading-frame and that these stop codons can be adjacent in the sequence or separated by intervening codons. Where more than one stop codon is introduced into a single open-reading-frame, such alterations can be generated by a single or multiple oligonucleotides and can be generated simultaneously or by sequential mutagenesis of the target nucleic acid.

Original codons*	Corresponding stop codon
<u>G</u> GGA (glycine), A GA (arginine), <u>C</u> GA (arginine), <u>T</u> TA (leucine), T <u>C</u> A (serine), T <u>G</u> T (cysteine), T <u>G</u> <u>G</u> (tryptophan), T <u>G</u> <u>C</u> (cysteine)	TGA
A AG (lysine), <u>G</u> AG (glutamate), <u>C</u> AG (glutamine), <u>T</u> TG (leucine), T <u>C</u> G (serine), T <u>G</u> <u>G</u> (tryptophan), TAT (cysteine), T <u>A</u> <u>C</u> (tyrosine)	TAG
<u>A</u> AA (lysine), <u>G</u> AA (glutamate), <u>C</u> AA (glutamine), <u>T</u> TA (leucine), T <u>C</u> A (serine), TAT (cysteine), T <u>A</u> <u>C</u> (tyrosine)	TAA

*The amino acid encoded by the original codon is shown in parentheses and the base targeted for alteration to convert the codon to the corresponding stop codon is underlined and in bold

The oligonucleotides of the invention are designed as substrates for homologous pairing and repair enzymes and as such have a unique backbone composition that differs from chimeric RNA-DNA double hairpin oligonucleotides, antisense oligonucleotides, and/or other poly- or oligo-nucleotides used for altering genomic DNA, such as triplex forming oligonucleotides. The single-stranded oligo-
5 nucleotides described herein are inexpensive to synthesize and easy to purify. In side-by-side comparisons, an optimized single-stranded oligonucleotide comprising modified residues as described herein is significantly more efficient than a chimeric RNA-DNA double hairpin oligonucleotide in directing a base substitution or frameshift mutation in a cell-free extract assay.

We have discovered that single-stranded oligonucleotides having a DNA domain
10 surrounding the targeted base, with the domain preferably central to the poly- or oligo-nucleotide, and having at least one modified end, preferably at the 3' terminal region, are able to alter a target genetic sequence and with an efficiency that is higher than chimeric RNA-DNA double hairpin oligonucleotides disclosed in US Patent 5,565,350. Preferred oligonucleotides of the invention have at least two modified bases on at least one of the termini, preferably the 3' terminus of the oligonucleotide. Oligonucleotides
15 of the invention can efficiently be used to introduce targeted alterations in a genetic sequence of DNA in the presence of human, animal, plant, fungal (including yeast) proteins and in cells of different types including, for example, plant cells, fungal cells including *S. cerevisiae*, *Ustilago maydis*, *Candida albicans*, and mammalian cells. Particularly preferred are cells and cell extracts derived from plants including, for example, experimental model plants such as *Chlamydomonas reinhardtii*, *Physcomitrella patens*, and
20 *Arabidopsis thaliana* in addition to crop plants such as cauliflower (*Brassica oleracea*), artichoke (*Cynara scolymus*), fruits such as apples (*Malus*, e.g. *domesticus*), mangoes (*Mangifera*, e.g. *indica*), banana (*Musa*, e.g. *acuminata*), berries (such as currant, *Ribes*, e.g. *rubrum*), kiwifruit (*Actinidia*, e.g. *chinensis*), grapes (*Vitis*, e.g. *vinifera*), bell peppers (*Capsicum*, e.g. *annuum*), cherries (such as the sweet cherry, *Prunus*, e.g. *avium*), cucumber (*Cucumis*, e.g. *sativus*), melons (*Cucumis*, e.g. *melo*), nuts (such as
25 walnut, *Juglans*, e.g. *regia*; peanut, *Arachis hypogaeae*), orange (*Citrus*, e.g. *maxima*), peach (*Prunus*, e.g. *persica*), pear (*Pyrus*, e.g. *communis*), plum (*Prunus*, e.g. *domestica*), strawberry (*Fragaria*, e.g. *moschata* or *vesca*), tomato (*Lycopersicon*, e.g. *esculentum*); leaves and forage, such as alfalfa (*Medicago*, e.g. *sativa* or *truncatula*), cabbage (e.g. *Brassica oleracea*), endive (*Cichorium*, e.g. *endivia*), leek (*Allium*, e.g. *porrum*), lettuce (*Lactuca*, e.g. *sativa*), spinach (*Spinacia*, e.g. *oleraceae*), tobacco (*Nicotiana*, e.g. *tabacum*); roots, such as arrowroot (*Maranta*, e.g. *arundinacea*), beet (*Beta*, e.g. *vulgaris*), carrot
30 (*Daucus*, e.g. *carota*), cassava (*Manihot*, e.g. *esculenta*), turnip (*Brassica*, e.g. *rapa*), radish (*Raphanus*, e.g. *sativus*), yam (*Dioscorea*, e.g. *esculenta*), sweet potato (*Ipomoea batatas*); seeds, including oilseeds,

such as beans (*Phaseolus*, e.g. *vulgaris*), pea (*Pisum*, e.g. *sativum*), soybean (*Glycine*, e.g. *max*), cowpea (*Vigna unguiculata*), mothbean (*Vigna aconitifolia*), wheat (*Triticum*, e.g. *aestivum*), sorghum (*Sorghum* e.g. *bicolor*), barley (*Hordeum*, e.g. *vulgare*), corn (*Zea*, e.g. *mays*), rice (*Oryza*, e.g. *sativa*), rapeseed (*Brassica napus*), millet (*Panicum* sp.), sunflower (*Helianthus annuus*), oats (*Avena sativa*), chickpea (*Cicer*, e.g. *arietinum*); tubers, such as kohlrabi (*Brassica*, e.g. *oleraceae*), potato (*Solanum*, e.g. *tuberosum*) and the like; fiber and wood plants, such as flax (*Linum* e.g. *usitatissimum*), cotton (*Gossypium* e.g. *hirsutum*), pine (*Pinus* sp.), oak (*Quercus* sp.), eucalyptus (*Eucalyptus* sp.), and the like and ornamental plants such as turfgrass (*Lolium*, e.g. *rigidum*), petunia (*Petunia*, e.g. *x hybrida*), hyacinth (*Hyacinthus orientalis*), carnation (*Dianthus* e.g. *caryophyllus*), delphinium (*Delphinium*, e.g. *ajacis*), Job's tears (*Coix lacryma-jobi*), snapdragon (*Antirrhinum majus*), poppy (*Papaver*, e.g. *nudicaule*), lilac (*Syringa*, e.g. *vulgaris*), hydrangea (*Hydrangea* e.g. *macrophylla*), roses (including Gallicas, Albas, Damasks, Damask Perpetuals, Centifolias, Chinas, Teas and Hybrid Teas) and ornamental goldenrods (e.g. *Solidago* spp.). Such plant cells can then be used to regenerate whole plants according to methods described herein or any method known in the art. The DNA domain of the oligonucleotides is preferably fully complementary to one strand of the gene target, except for the mismatch base or bases responsible for the gene alteration event(s). On either side of the preferably central DNA domain, the contiguous bases may be either RNA bases or, preferably, are primarily DNA bases. The central DNA domain is generally at least 8 nucleotides in length. The base(s) targeted for alteration in the most preferred embodiments are at least about 8, 9 or 10 bases from one end of the oligonucleotide.

According to certain embodiments, one or both of the termini of the oligonucleotides of the present invention comprise phosphorothioate modifications, LNA backbone (including LNA derivatives and analogs) modifications, or 2'-O-methyl base analogs, or any combination of these modifications. Oligonucleotides comprising 2'-O-methyl or LNA analogs are a mixed DNA/RNA polymer. The oligonucleotides of the invention are, however, single-stranded and are not designed to form a stable internal duplex structure within the oligonucleotide. The efficiency of gene alteration is surprisingly increased with oligonucleotides having internal complementary sequence comprising phosphorothioate modified bases as compared to 2'-O-methyl modifications. This result indicates that specific chemical interactions are involved between the converting oligonucleotide and the proteins involved in the conversion. The effect of other such chemical interactions to produce nuclease resistant termini using modifications other than LNA (including LNA derivatives or analogs), phosphorothioate linkages, or 2'-O-methyl analog incorporation into an oligonucleotide can not yet be predicted because the proteins

involved in the alteration process and their particular chemical interaction with the oligonucleotide substituents are not yet known and cannot be predicted.

In the examples, oligonucleotides of defined sequence are provided for alteration of genes in particular plants. Provided the teachings of the instant application, one of skill in the art could readily design oligonucleotides to introduce analogous alterations in homologous genes from any plant. Furthermore, in the tables of these examples, the oligonucleotides of the invention are not limited to the particular sequences disclosed. The oligonucleotides of the invention include extensions of the appropriate sequence of the longer 120 base oligonucleotides which can be added base by base to the smallest disclosed oligonucleotides of 17 bases. Thus the oligonucleotides of the invention include for each correcting change, oligonucleotides of length 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, or 120 with further single-nucleotide additions up to the longest sequence disclosed. In some embodiments, longer nucleic acids of up to 240 bases which comprise the sequences disclosed herein may be used. Moreover, the oligonucleotides of the invention do not require a symmetrical extension on either side of the central DNA domain. Similarly, the oligonucleotides of the invention as disclosed in the various tables for alteration of particular plant genes contain phosphorothioate linkages, 2'-O-methyl analog or LNA (including LNA derivatives and analogs) or any combination of these modifications just as the assay oligonucleotides do.

The present invention, however, is not limited to oligonucleotides that contain any particular nuclease resistant modification. Oligonucleotides of the invention may be altered with any combination of additional LNAs (including LNA derivatives and analogs), phosphorothioate linkages or 2'-O-methyl analogs to maximize conversion efficiency. For oligonucleotides of the invention that are longer than about 17 to about 25 bases in length, internal as well as terminal region segments of the backbone may be altered. Alternatively, simple fold-back structures at each end of a oligonucleotide or appended end groups may be used in addition to a modified backbone for conferring additional nuclease resistance.

The different oligonucleotides of the present invention preferably contain more than one of the aforementioned backbone modifications at each end. In some embodiments, the backbone modifications are adjacent to one another. However, the optimal number and placement of backbone modifications for any individual oligonucleotide will vary with the length of the oligonucleotide and the particular type of backbone modification(s) that are used. If constructs of identical sequence having

phosphorothioate linkages are compared, 2, 3, 4, 5, or 6 phosphorothioate linkages at each end are preferred. If constructs of identical sequence having 2'-O-methyl base analogs are compared, 1, 2, 3 or 4 analogs are preferred. The optimal number and type of backbone modifications for any particular oligonucleotide useful for altering target DNA may be determined empirically by comparing the alteration efficiency of the oligonucleotide comprising any combination of the modifications to a control molecule of comparable sequence using any of the assays described herein. The optimal position(s) for oligonucleotide modifications for a maximally efficient altering oligonucleotide can be determined by testing the various modifications as compared to control molecule of comparable sequence in one of the assays disclosed herein. In such assays, a control molecule includes, e.g., a completely 2'-O-methyl substituted molecule, a completely complementary oligonucleotide, or a chimeric RNA-DNA double hairpin.

Increasing the number of phosphorothioate linkages, LNAs or 2'-O-methyl bases beyond the preferred number generally decreases the gene repair activity of a 25 nucleotide long oligonucleotide. Based on analysis of the concentration of oligonucleotide present in the extract after different time periods of incubation, it is believed that the terminal modifications impart nuclease resistance to the oligonucleotide thereby allowing it to survive within the cellular environment. However, this may not be the only possible mechanism by which such modifications confer greater efficiency of conversion. For example, as disclosed herein, certain modifications to oligonucleotides confer a greater improvement to the efficiency of conversion than other modifications.

Efficiency of conversion is defined herein as the percentage of recovered substrate molecules that have undergone a conversion event. Depending on the nature of the target genetic material, e.g. the genome of a cell, efficiency could be represented as the proportion of cells or clones containing an extrachromosomal element that exhibit a particular phenotype. Alternatively, representative samples of the target genetic material can be sequenced to determine the percentage that have acquired the desired change. The oligonucleotides of the invention in different embodiments can alter DNA two, three, four, five, six, seven, eight, nine, ten, twelve, fifteen, twenty, thirty, and fifty or more fold more than control oligonucleotides. Such control oligonucleotides are oligonucleotides with fully phosphorothiolated linkages, oligonucleotides that are fully substituted with 2'-O-methyl analogs, a perfectly matched oligonucleotide that is fully complementary to a target sequence or a chimeric DNA-RNA double hairpin oligonucleotide such as disclosed in US Patent 5,565,350.

In addition, for a given oligonucleotide length, additional modifications interfere with the ability of the oligonucleotide to act in concert with the cellular recombination or repair enzyme machinery

which is necessary and required to mediate a targeted substitution, addition or deletion event in DNA. For example, fully phosphorothiolated or fully 2-O-methylated molecules are inefficient in targeted gene alteration.

5 The oligonucleotides of the invention as optimized for the purpose of targeted alteration of genetic material, including gene knockout or repair, are different in structure from antisense oligonucleotides that may possess a similar mixed chemical composition backbone. The oligonucleotides of the invention differ from such antisense oligonucleotides in chemical composition, structure, sequence, and in their ability to alter genomic DNA. Significantly, antisense oligonucleotides fail to direct targeted gene alteration. The oligonucleotides of the invention may target either strand of DNA and can include
10 any component of the genome including, for example, intron and exon sequences. The preferred embodiment of the invention is a modified oligonucleotide that binds to the non-transcribed strand of a genomic DNA duplex. In other words, the preferred oligonucleotides of the invention target the sense strand of the DNA, i.e. the oligonucleotides of the invention are complementary to the non-transcribed strand of the target duplex DNA. The sequence of the non-transcribed strand of a DNA duplex is found in
15 the mRNA produced from that duplex, given that mRNA uses uracil-containing nucleotides in place of thymine-containing nucleotides.

Moreover, the initial observation that single-stranded oligonucleotides comprising these modifications and lacking any particular triplex forming domain have reproducibly enhanced gene alteration activity in a variety of assay systems as compared to a chimeric RNA-DNA double-stranded
20 hairpin control or single-stranded oligonucleotides comprising other backbone modifications was surprising. The single-stranded molecules of the invention totally lack the complementary RNA binding structure that stabilizes a normal chimeric double-stranded hairpin of the type disclosed in U.S. Patent 5,565,350 yet is more effective in producing targeted base conversion as compared to such a chimeric RNA-DNA double-stranded hairpin. In addition, the molecules of the invention lack any
25 particular triplex forming domain involved in Hoogsteen interactions with the DNA double helix and required by other known oligonucleotides in other oligonucleotide-dependant gene conversion systems. Although the lack of these functional domains was expected to decrease the efficiency of an alteration in a sequence, just the opposite occurs: the efficiency of sequence alteration using the modified oligonucleotides of the invention is higher than the efficiency of sequence alteration using a chimeric
30 RNA-DNA hairpin targeting the same sequence alteration. Moreover, the efficiency of sequence alteration or gene conversion directed by an unmodified oligonucleotide is many times lower as compared to a control chimeric RNA-DNA molecule or the modified oligonucleotides of the invention targeting the

same sequence alteration. Similarly, molecules containing at least 3 2'-O-methyl base analogs are about four to five fold less efficient as compared to an oligonucleotide having the same number of phosphorothioate linkages.

5 The oligonucleotides of the present invention for alteration of a single base are about 17 to about 121 nucleotides in length, preferably about 17 to about 74 nucleotides in length. Most preferably, however, the oligonucleotides of the present invention are at least about 25 bases in length, unless there are self-dimerization structures within the oligonucleotide. If the oligonucleotide has such an unfavorable structure, lengths longer than 35 bases are preferred. Oligonucleotides with modified ends both shorter and longer than certain of the exemplified, modified oligonucleotides herein function as gene repair or
10 gene knockout agents and are within the scope of the present invention.

Once an oligomer is chosen, it can be tested for its tendency to self-dimerize, since self-dimerization may result in reduced efficiency of alteration of genetic information. Checking for self-dimerization tendency can be accomplished manually or, preferably, using a software program. One such program is Oligo Analyzer 2.0, available through Integrated DNA Technologies (Coralville, IA 52241)
15 (<http://www.idtdna.com>); this program is available for use on the world wide web at

[http://www.idtdna.com/program/oligoanalyzer/
oligoanalyzer.asp](http://www.idtdna.com/program/oligoanalyzer/oligoanalyzer.asp).

For each oligonucleotide sequence input into the program, Oligo Analyzer 2.0 reports possible self-dimerized duplex forms, which are usually only partially duplexed, along with the free energy change
20 associated with such self-dimerization. Delta G-values that are negative and large in magnitude, indicating strong self-dimerization potential, are automatically flagged by the software as "bad". Another software program that analyzes oligomers for pair dimer formation is Primer Select from DNASTAR, Inc., 1228 S. Park St., Madison, WI 53715, Phone: (608) 258-7420 (<http://www.dnastar.com/products/PrimerSelect.html>).

25 If the sequence is subject to significant self-dimerization, the addition of further sequence flanking the "repair" nucleotide can improve gene correction frequency.

Generally, the oligonucleotides of the present invention are identical in sequence to one strand of the target DNA, which can be either strand of the target DNA, with the exception of one or more targeted bases positioned within the DNA domain of the oligonucleotide, and preferably toward the middle
30 between the modified terminal regions. Preferably, the difference in sequence of the oligonucleotide as compared to the targeted genomic DNA is located at about the middle of the oligonucleotide sequence. In a preferred embodiment, the oligonucleotides of the invention are complementary to the non-transcribed

strand of a duplex. In other words, the preferred oligonucleotides target the sense strand of the DNA, i.e. the oligonucleotides of the invention are preferably complementary to the strand of the target DNA the sequence of which is found in the mRNA.

5 The oligonucleotides of the invention can include more than a single base change. In an oligonucleotide that is about a 70-mer, with at least one modified residue incorporated on the ends, as disclosed herein, multiple bases can be simultaneously targeted for change. The target bases may be up to 27 nucleotides apart and may not be changed together in all resultant plasmids in all cases. There is a frequency distribution such that the closer the target bases are to each other in the central DNA domain, within the oligonucleotides of the invention, the higher the frequency of change in a given cell. Target
10 bases only two nucleotides apart are changed together in every case that has been analyzed. The farther apart the two target bases are, the less frequent the simultaneous change. Thus, oligonucleotides of the invention may be used to repair or alter multiple bases rather than just one single base. For example, in a 74-mer oligonucleotide having a central base targeted for change, a base change event up to about 27 nucleotides away can also be effected. The positions of the altering bases within the
15 oligonucleotide can be optimized using any one of the assays described herein. Preferably, the altering bases are at least about 8 nucleotides from one end of the oligonucleotide.

The oligonucleotides of the present invention can be introduced into cells by any suitable means. According to certain preferred embodiments, the modified oligonucleotides may be used alone. Suitable means, however, include the use of polycations, cationic lipids, liposomes, polyethylenimine
20 (PEI), electroporation, biolistics, microinjection and other methods known in the art to facilitate cellular uptake. For plant cells, biolistic or particle bombardment methods are typically used. According to certain preferred embodiments of the present invention, isolated plant cells are treated in culture according to the methods of the invention, to mutate or repair a target gene. Alternatively, plant target DNA may be modified *in vitro* or in another cell type, including for example, yeast or bacterial cells and then introduced
25 into a plant cell as, for example, a T-DNA. Plant cells thus modified may be used to regenerate the whole organism as, for example, in a plant having a desired targeted genomic change. In other instances, targeted genomic alteration, including repair or mutagenesis, may take place *in vivo* following direct administration of the modified, single-stranded oligonucleotides of the invention to a subject.

30 The single-stranded, modified oligonucleotides of the present invention have numerous applications as gene repair, gene modification, or gene knockout agents. Such oligonucleotides may be advantageously used, for example, to introduce or correct multiple point mutations. Each mutation leads to the addition, deletion or substitution of at least one base pair. The methods of the present invention

offer distinct advantages over other methods of altering the genetic makeup of an organism, in that only the individually targeted bases are altered. No additional foreign DNA sequences are added to the genetic complement of the organism. Such agents may, for example, be used to develop plants with improved traits by rationally changing the sequence of selected genes in isolated cells and using these modified cells to regenerate whole plants having the altered gene. See, e.g., U.S. Patent 6,046,380 and U.S. Patent 5,905,185 incorporated herein by reference. Such plants produced using the compositions of the invention lack additional undesirable selectable markers or other foreign DNA sequences. Targeted base pair substitution or frameshift mutations introduced by an oligonucleotide in the presence of a cell-free extract also provides a way to modify the sequence of extrachromosomal elements, including, for example, plasmids, cosmids and artificial chromosomes. The oligonucleotides of the invention also simplify the production of plants having particular modified or inactivated genes. Altered plant model systems such as those produced using the methods and oligonucleotides of the invention are invaluable in determining the function of a gene and in evaluating drugs. The oligonucleotides and methods of the present invention may also be used to introduce molecular markers, including, for example, SNPs, RFLPs, AFLPs and CAPs.

The purified oligonucleotide compositions may be formulated in accordance with routine procedures depending on the target. For example, purified oligonucleotide can be used directly in a standard reaction mixture to introduce alterations into targeted DNA *in vitro* or where cells are the target as a composition adapted for bathing cells in culture or for microinjection into cells in culture. The purified oligonucleotide compositions may also be provided on coated microbeads for biolistic delivery into plant cells. Where necessary, the composition may also include a solubilizing agent. Generally, the ingredients will be supplied either separately or mixed together in single-use form, for example, as a dry, lyophilized powder or water-free concentrate. In general, dosage required for efficient targeted gene alteration will range from about 0.001 to 50,000 µg/kg target tissue, preferably between 1 to 250 µg/kg, and most preferably at a concentration of between 30 and 60 micromolar.

For cell administration, direct injection into the nucleus, biolistic bombardment, electroporation, liposome transfer and calcium phosphate precipitation may be used. In yeast, lithium acetate or spheroplast transformation may also be used. In a preferred method, the administration is performed with a liposomal transfer compound, e.g., DOTAP (Boehringer-Mannheim) or an equivalent such as lipofectin. The amount of the oligonucleotide used is about 500 nanograms in 3 micrograms of DOTAP per 100,000 cells. For electroporation, between 20 and 2000 nanograms of oligonucleotide per million cells to be electroporated is an appropriate range of dosages which can be increased to improve

efficiency of genetic alteration upon review of the appropriate sequence according to the methods described herein. For biolistic delivery, microbeads are generally coated with resuspended oligonucleotides, which range of oligonucleotide to microbead concentration can be similarly adjusted to improve efficiency as determined using one of the assay methods described herein, starting with about 0.05 to 1 microgram of oligonucleotide to 25 microgram of 1.0 micrometer gold beads or similar microcarrier.

Another aspect of the invention is a kit comprising at least one oligonucleotide of the invention. The kit may comprise an additional reagent or article of manufacture. The additional reagent or article of manufacture may comprise a delivery mechanism, cell extract, a cell, or a plasmid, such as one of those disclosed in the Figures herein, for use in an assay of the invention. Alternatively, the invention includes a kit comprising an isogenic set of cells in which each cell in the kit comprises a different altered amino acid for a target protein encoded by a targeted altered gene within the cell produced according to the methods of the invention.

Brief Description Of The Drawings

Figure 1. *Flow diagram for the generation of modified single-stranded oligonucleotides.* The upper strands of chimeric oligonucleotides I and II are separated into pathways resulting in the generation of single-stranded oligonucleotides that contain (A) 2'-O-methyl RNA nucleotides or (B) phosphorothioate linkages. Fold changes in repair activity for correction of kan^r in the HUH7 cell-free extract are presented in parenthesis. HUH7 cells are described in Nakabayashi et al., Cancer Research 42: 3858-3863 (1982). Each single-stranded oligonucleotide is 25 bases in length and contains a G residue mismatched to the complementary sequence of the kan^r gene. The numbers 3, 6, 8, 10, 12 and 12.5 respectively indicate how many phosphorothioate linkages (S) or 2'-O-methyl RNA nucleotides (R) are at each end of the molecule. Hence oligo 12S/25G contains an all phosphorothioate backbone, displayed as a dotted line. Smooth lines indicate DNA residues, wavy lines indicate 2'-O-methyl RNA residues and the carat indicates the mismatched base site (G). Figure 1(C) provides a schematic plasmid indicating the sequence of the kan chimeric double-stranded hairpin oligonucleotide (left) and the sequence the tet chimeric double-stranded hairpin oligonucleotide used in other experiments. Figure 1(D) provides a flow chart of a kan experiment in which a chimeric double-stranded hairpin oligonucleotide is used.

Figure 2. *Genetic readout system for correction of a point mutation in plasmid pK^m4021.* A mutant kanamycin gene harbored in plasmid pK^m4021 is the target for correction by oligonucleotides.

The mutant G is converted to a C by the action of the oligo. Corrected plasmids confer resistance to kanamycin in *E.coli* (DH10B) after electroporation leading to the genetic readout and colony counts.

Figure 3: *Target plasmid and sequence correction of a frameshift mutation by chimeric and single-stranded oligonucleotides.* (A) Plasmid pT^Δ208 contains a single base deletion mutation at position 208 rendering it unable to confer tet resistance. The target sequence presented below indicates the insertion of a T directed by the oligonucleotides to re-establish the resistant phenotype. (B) DNA sequence confirming base insertion directed by Tet 3S/25G; the yellow highlight indicates the position of frameshift repair.

Figure 4. *DNA sequences of representative kan^r colonies.* Confirmation of sequence alteration directed by the indicated molecule is presented along with a table outlining codon distribution. Note that 10S/25G and 12S/25G elicit both mixed and unfaithful gene repair. The number of clones sequenced is listed in parentheses next to the designation for the single-stranded oligonucleotide. A plus (+) symbol indicates the codon identified while a figure after the (+) symbol indicates the number of colonies with a particular sequence. TAC/TAG indicates a mixed peak. Representative DNA sequences are presented below the table with yellow highlighting altered residues.

Figure 5. *Gene correction in HeLa cells.* Representative oligonucleotides of the invention are co-transfected with the pCMVneo(+)FIAsH plasmid (shown in Figure 9) into HeLa cells. Ligand is diffused into cells after co-transfection of plasmid and oligonucleotides. Green fluorescence indicates gene correction of the mutation in the antibiotic resistance gene. Correction of the mutation results in the expression of a fusion protein that carries a marker ligand binding site and when the fusion protein binds the ligand, a green fluorescence is emitted. The ligand is produced by Aurora Biosciences and can readily diffuse into cells enabling a measurement of corrected protein function; the protein must bind the ligand directly to induce fluorescence. Hence cells bearing the corrected plasmid gene appear green while "uncorrected" cells remain colorless.

Figure 6. *Z-series imaging of corrected cells.* Serial cross-sections of the HeLa cell represented in Figure 5 are produced by Zeiss 510 LSM confocal microscope revealing that the fusion protein is contained within the cell.

Figure 7. *Hygromycin-eGFP target plasmids.* (A) Plasmid pAURHYG(ins)GFP contains a single base insertion mutation between nucleotides 136 and 137, at codon 46, of the Hygromycin B coding sequence (cgs) which is transcribed from the constitutive ADH1 promoter. The target sequence presented below indicates the deletion of an A and the substitution of a C for a T directed by the oligonucleotides to re-establish the resistant phenotype. (B) Plasmid pAURHYG(rep)GFP contains a

base substitution mutation introducing a G at nucleotide 137, at codon 46, of the Hygromycin B coding sequence (cds). The target sequence presented below the diagram indicates the amino acid conservative replacement of G with C, restoring gene function.

Figure 8. *Oligonucleotides for correction of hygromycin resistance gene*. The sequence of the oligonucleotides used in experiments to assay correction of a hygromycin resistance gene are shown. DNA residues are shown in capital letters, RNA residues are shown in lowercase and nucleotides with a phosphorothioate backbone are capitalized and underlined.

Figure 9. *pAURNeo(-)FIAsH plasmid*. This figure describes the plasmid structure, target sequence, oligonucleotides, and the basis for detection of the gene alteration event by fluorescence.

Figure 10. *pYESHyg(x)eGFP plasmid*. This plasmid is a construct similar to the pAURHyg(x)eGFP construct shown in Figure 7, except the promoter is the inducible GAL1 promoter. This promoter is inducible with galactose, leaky in the presence of raffinose, and repressed in the presence of dextrose.

Figure 11. *pBI-HygeGFP plasmid*. This plasmid is a construct based on the plasmids pBI101, pBI 101.2, pBI101.3 or pBI 121 available from Clontech in which HygeGFP replaces the beta-glucuronidase gene of the Clontech plasmids. The different Clontech plasmids vary by a reading frame shift relative to the polylinker, or the presence of the Cauliflower mosaic virus promoter.

The following examples are provided by way of illustration only, and are not intended to limit the scope of the invention disclosed herein.

EXAMPLE 1

Assay Method For Base Alteration And Preferred Oligonucleotide Selection

In this example, single-stranded and double-hairpin oligonucleotides with chimeric backbones (see Figure 1 for structures (A and B) and sequences (C and D) of assay oligonucleotides) are used to correct a point mutation in the kanamycin gene of pK^sm4021 (Figure 2) or the tetracycline gene of pT^sΔ208 (Figure 3). All kan oligonucleotides share the same 25 base sequence surrounding the target base identified for change, just as all tet oligonucleotides do. The sequence is given in Figures 1C and Figure 1D. Each plasmid contains a functional ampicillin gene. Kanamycin gene function is restored when a G at position 4021 is converted to a C (via a substitution mutation); tetracycline gene function is restored when a deletion at position 208 is replaced by a C (via frameshift mutation). A separate plasmid, pAURNeo(-)FIAsH (Figure 9), bearing the kan^s gene is used in the cell culture experiments. This plasmid was constructed by inserting a synthetic expression cassette containing a neomycin phosphotransferase

(kanamycin resistance) gene and an extended reading frame that encodes a receptor for the FIAsh ligand into the pAUR123 shuttle vector (Panvera Corp., Madison, WI). The resulting construct replicates in *S. cerevisiae* at low copy number, confers resistance to aureobasidinA and constitutively expresses either the Neo-+/FIAsh fusion product (after alteration) or the truncated Neo-/FIAsh product (before alteration) from the ADH1 promoter. By extending the reading frame of this gene to code for a unique peptide sequence capable of binding a small ligand to form a fluorescent complex, restoration of expression by correction of the stop codon can be detected in real time using confocal microscopy.

Additional constructs can be made to test additional gene alteration events or for specific use in different expression systems. For example, alternative comparable plant plasmids or integration vectors such as, e.g. those based on T-DNA, can be constructed for stable expression in plant cells according to the disclosures herein. Such constructs would use a plant specific promoter such as, e.g., cauliflower mosaic virus 35S promoter, to replace the promoters directing expression of the neo, hyg or aureobasidinA resistance gene disclosed herein, including for example, in Figures 7B, 9 and 10 herein. Moreover, the green fluorescent protein (GFP) sequence used herein may be modified to increase expression in plant cells such as Arabidopsis and the other plants disclosed herein as described in Haseloff et al., Proc. Natl.Acad. Sci. 94(6): 2122-7 (1997), Rouwendal et al. Plant Mol. Biol. 33(6): 989-99 (1997) and Hu et al. FEBS Lett. 369(2-3): 331-4 (1995). Codon usage for optimal expression of GFP in plants results from increasing the frequency of codons with a C or a G in the third position from 32 to about 60%. Specific constructs are disclosed and can be used as follows with such plant specific alterations.

We also construct three mammalian expression vectors, pHyg(rep)eGFP, pHyg(Δ)eGFP, pHyg(ins)eGFP, that contain a substitution mutation at nucleotide 137 of the hygromycin-B coding sequence. (rep) indicates a T137→G replacement, (Δ) represents a deletion of the G137 and (ins) represents an A insertion between nucleotides 136 and 137. All point mutations create a nonsense termination codon at residue 46. We use pHYGeGFP plasmid (Invitrogen, CA) DNA as a template to introduce the mutations into the hygromycin-eGFP fusion gene by a two step site-directed mutagenesis PCR protocol. First, we generate overlapping 5' and a 3' amplicons surrounding the mutation site by PCR for each of the point mutation sites. A 215 bp 5' amplicon for the (rep), (Δ) or (ins) was generated by polymerization from oligonucleotide primer HygEGFPf (5'-AATACGACTCACTATAGG-3') to primer Hygrepr (5'-GACCTATCCACGCCCTCC-3'), Hyg Δ r (5'-GACTATCCACGCCCTCC-3'), or Hyginsr (5'-GACATTATCCACGCCCTCC-3'), respectively. We generate a 300bp 3' amplicon for the (rep), (Δ) or (ins) by polymerization from oligonucleotide primers Hygrepf (5'-CTGGGATAGGTCCTGCGG-3'), Hyg Δ f

(5'-CGTGGATAGTCCTGCGG-3'), Hyginsf (5'-CGTGGATAATGTCCTGCGG-3'), respectively to primer HygEGFP_r (5'-AAATCACGCCATGTAGTG-3'). We mix 20 ng of each of the resultant 5' and 3' overlapping amplicon mutation sets and use the mixture as a template to amplify a 523 bp fragment of the Hygromycin gene spanning the KpnI and RsrII restriction endonuclease sites. We use the Expand PCR system (Roche) to generate all amplicons with 25 cycles of denaturing at 94°C for 10 seconds, annealing at 55°C for 20 seconds and elongation at 68°C for 1 minute. We digest 10 µg of vector pHYGeGFP and 5 µg of the resulting fragments for each mutation with KpnI and RsrII (NEB) and gel purify the fragment for enzymatic ligation. We ligate each mutated insert into pHYGeGFP vector at 3:1 molar ratio using T4 DNA ligase (Roche). We screen clones by restriction digest, confirm the mutation by Sanger dideoxy chain termination sequencing and purify the plasmid using a Qiagen maxiprep kit.

Oligonucleotide synthesis and cells. Chimeric oligonucleotides and single-stranded oligonucleotides (including those with the indicated modifications) are synthesized using available phosphoramidites on controlled pore glass supports. After deprotection and detachment from the solid support, each oligonucleotide is gel-purified using, for example, procedures such as those described in Gamper *et al.*, *Biochem.* 39, 5808-5816 (2000) and the concentrations determined spectrophotometrically (33 or 40 µg/ml per A₂₆₀ unit of single-stranded or hairpin oligomer). HUH7 cells are grown in DMEM, 10% FBS, 2mM glutamine, 0.5% pen/strep. The *E.coli* strain, DH10B, is obtained from Life Technologies (Gaithersburg, MD); DH10B cells contain a mutation in the RECA gene (*recA*).

Cell-free extracts. Although this portion of this example is directed to mammalian systems, similar extracts from plants can be prepared as disclosed elsewhere in this application and used as disclosed in this example. We prepare cell-free extracts from HUH7 cells or other mammalian cells, as follows. We employ this protocol with essentially any mammalian cell including, for example, H1299 cells (human epithelial carcinoma, non-small cell lung cancer), C1271 (immortal murine mammary epithelial cells), MEF (mouse embryonic fibroblasts), HEC-1-A (human uterine carcinoma), HCT15 (human colon cancer), HCT116 (human colon carcinoma), LoVo (human colon adenocarcinoma), and HeLa (human cervical carcinoma). We harvest approximately 2x10⁸ cells. We then wash the cells immediately in cold hypotonic buffer (20 mM HEPES, pH7.5; 5 mM KCl; 1.5 mM MgCl₂; 1 mM DTT) with 250 mM sucrose. We then resuspend the cells in cold hypotonic buffer without sucrose and after 15 minutes we lyse the cells with 25 strokes of a Dounce homogenizer using a tight fitting pestle. We incubate the lysed cells for 60 minutes on ice and centrifuge the sample for 15 minutes at 12000xg. The cytoplasmic fraction is enriched with nuclear proteins due to the extended co-incubation of the fractions following cell breakage.

We then immediately aliquote and freeze the supernatant at -80°C. We determine the protein concentration in the extract by the Bradford assay.

We also perform these experiments with cell-free extracts obtained from fungal cells, including, for example, *S. cerevisiae* (yeast), *Ustilago maydis*, and *Candida albicans*. For example, we grow yeast cells into log phase in 2L YPD medium for 3 days at 30°C. We then centrifuge the cultures at 5000xg, resuspend the pellets in a 10% sucrose, 50 mM Tris, 1mM EDTA lysis solution and freeze them on dry ice. After thawing, we add KCl, spermidine and lyticase to final concentrations of 0.25 mM, 5 mM and 0.1 mg/ml, respectively. We incubate the suspension on ice for 60 minutes, add PMSF and Triton X100 to final concentrations of 0.1 mM and 0.1% and continue to incubate on ice for 20 minutes. We centrifuge the lysate at 3000xg for 10 minutes to remove larger debris. We then remove the supernatant and clarify it by centrifuging at 30000xg for 15 minutes. We then add glycerol to the clarified extract to a concentration of 10% (v/v) and freeze aliquots at -80°C. We determine the protein concentration of the extract by the Bradford assay.

Reaction mixtures of 50 µl are used, consisting of 10-30 µg protein of cell-free extract, which can be optionally substituted with purified proteins or enriched fractions, about 1.5 µg chimeric double-hairpin oligonucleotide or 0.55 µg single-stranded molecule (3S/25G or 6S/25G, see Figure 1), and 1 µg of plasmid DNA (see Figures 2 and 3) in a reaction buffer of 20 mM Tris, pH 7.4, 15 mM MgCl₂, 0.4 mM DTT, and 1.0 mM ATP. Reactions are initiated with extract and incubated at 30°C for 45 min. The reaction is stopped by placing the tubes on ice and then immediately deproteinized by two phenol/chloroform (1:1) extractions. Samples are then ethanol precipitated. The nucleic acid is pelleted at 15,000 r.p.m. at 4°C for 30 min., is washed with 70% ethanol, resuspended in 50 µl H₂O, and is stored at -20°C. 5 µl of plasmid from the resuspension (~100 ng) was transfected in 20 µl of DH10B cells by electroporation (400 V, 300 µF, 4 kΩ) in a Cell-Porator apparatus (Life Technologies). After electroporation, cells are transferred to a 14 ml Falcon snap-cap tube with 2 ml SOC and shaken at 37°C for 1 h. Enhancement of final kan colony counts is achieved by then adding 3 ml SOC with 10 µg/ml kanamycin and the cell suspension is shaken for a further 2 h at 37°C. Cells are then spun down at 3750 x g and the pellet is resuspended in 500 µl SOC. 200 µl is added undiluted to each of two kanamycin (50 µg/ml) agar plates and 200 µl of a 10⁵ dilution is added to an ampicillin (100 µg/ml) plate. After overnight 37°C incubation, bacterial colonies are counted using an Accucount 1000 (Biologics). Gene conversion effectiveness is measured as the ratio of the average of the kan colonies on both plates per amp colonies multiplied by 10⁻⁵ to correct for the amp dilution.

The following procedure can also be used. 5 µl of resuspended reaction mixtures (total volume 50 µl) are used to transform 20 µl aliquots of electro-competent DH10B bacteria using a Cell-Porator apparatus (Life Technologies). The mixtures are allowed to recover in 1 ml SOC at 37°C for 1 hour at which time 50 µg/ml kanamycin or 12 µg/ml tetracycline is added for an additional 3 hours.

5 Prior to plating, the bacteria are pelleted and resuspended in 200 µl of SOC. 100 µl aliquots are plated onto kan or tet agar plates and 100 µl of a 10⁻⁴ dilution of the cultures are concurrently plated on agar plates containing 100 µg/ml of ampicillin. Plating is performed in triplicate using sterile Pyrex beads. Colony counts are determined by an Accu-count 1000 plate reader (Biologics). Each plate contains 200-500 ampicillin resistant colonies or 0-500 tetracycline or kanamycin resistant colonies. Resistant colonies

10 are selected for plasmid extraction and DNA sequencing using an ABI Prism kit on an ABI 310 capillary sequencer (PE Biosystems).

Chimeric single-stranded oligonucleotides. In Figure 1 the upper strands of chimeric oligonucleotides I and II are separated into pathways resulting in the generation of single-stranded oligonucleotides that contain (Figure 1A) 2'-O-methyl RNA nucleotides or (Figure 1B) phosphorothioate

15 linkages. Fold changes in repair activity for correction of kan^s in the HUH7 cell-free extract are presented in parenthesis. Each single-stranded oligonucleotide is 25 bases in length and contains a G residue mismatched to the complementary sequence of the kan^s gene.

Molecules bearing 3, 6, 8, 10 and 12 phosphorothioate linkages in the terminal regions at each end of a backbone with a total of 24 linkages (25 bases) are tested in the kan^s system. Alternatively,

20 molecules bearing 2, 4, 5, 7, 9 and 11 in the terminal regions at each end are tested. The results of one such experiment, presented in Table 1 and Figure 1B, illustrate an enhancement of correction activity directed by some of these modified structures. In this illustrative example, the most efficient molecules contained 3 or 6 phosphorothioate linkages at each end of the 25-mer; the activities are approximately equal (molecules IX and X with results of 3.09 and 3.7 respectively). A reduction in alteration activity may

25 be observed as the number of modified linkages in the molecule is further increased. Interestingly, a single-strand molecule containing 24 phosphorothioate linkages is minimally active suggesting that this backbone modification when used throughout the molecule supports only a low level of targeted gene repair or alteration. Such a non-altering, completely modified molecule can provide a baseline control for determining efficiency of correction for a specific oligonucleotide molecule of known sequence in defining

30 the optimum oligonucleotide for a particular alteration event.

The efficiency of gene repair directed by phosphorothioate-modified, single-stranded molecules, in a length dependent fashion, led us to examine the length of the RNA modification used in

the original chimera as it relates to correction. Construct III represents the "RNA-containing" strand of chimera I and, as shown in Table 1 and Figure 2A, it promotes inefficient gene repair. But, as shown in the same figure, reducing the RNA residues on each end from 10 to 3 increases the frequency of repair. At equal levels of modification, however, 25-mers with 2'-O-methyl ribonucleotides were less effective gene repair agents than the same oligomers with phosphorothioate linkages. These results reinforce the fact that an RNA containing oligonucleotide is not as effective in promoting gene repair or alteration as a modified DNA oligonucleotide.

Repair of the kanamycin mutation requires a G→C exchange. To confirm that the specific desired correction alteration was obtained, colonies selected at random from multiple experiments are processed and the isolated plasmid DNA is sequenced. As seen in Figure 4, colonies generated through the action of the single-stranded molecules 3S/25G (IX), 6S/25G (X) and 8S/25G (XI) respectively contained plasmid molecules harboring the targeted base correction. While a few colonies appeared on plates derived from reaction mixtures containing 25-mers with 10 or 12 thioate linkages on both ends, the sequences of the plasmid molecules from these colonies contain nonspecific base changes. In these illustrative examples, the second base of the codon is changed (see Figure 3). These results show that modified single-strands can direct gene repair, but that efficiency and specificity are reduced when the 25-mers contain 10 or more phosphorothioate linkages at each end.

In Figure 1, the numbers 3, 6, 8, 10, 12 and 12.5 respectively indicate how many phosphorothioate linkages (S) or 2'-O-methyl RNA nucleotides (R) are at each end of the exemplified molecule although other molecules with 2, 4, 5, 7, 9 and 11 modifications at each end can also be tested. Hence oligo 12S/25G represents a 25-mer oligonucleotide which contains 12 phosphorothioate linkages on each side of the central G target mismatch base producing a fully phosphorothioate linked backbone, displayed as a dotted line. The dots are merely representative of a linkage in the figure and do not depict the actual number of linkages of the oligonucleotide. Smooth lines indicate DNA residues, wavy lines indicate 2'-O-methyl RNA residues and the carat indicates the mismatched base site (G).

Correction of a mutant kanamycin gene in cultured mammalian cells. Although this portion of this example is directed to cultured mammalian cells, comparable methods may be used using cultured plant cells or protoplasts of those cells from the plant species disclosed herein. The experiments are performed using different eukaryotic cells including plant and mammalian cells, including, for example, 293 cells (transformed human primary kidney cells), HeLa cells (human cervical carcinoma), and H1299 (human epithelial carcinoma, non-small cell lung cancer). HeLa cells are grown at 37°C and 5% CO₂ in a humidified incubator to a density of 2 x 10⁵ cells/ml in an 8 chamber slide (Lab-Tek). After replacing the

regular DMEM with Optimem, the cells are co-transfected with 10 µg of plasmid pAURNeo(-)FIAsH and 5 µg of modified single-stranded oligonucleotide (3S/25G) that is previously complexed with 10 µg lipofectamine, according to the manufacturer's directions (Life Technologies). The cells are treated with the liposome-DNA-oligo mix for 6 hrs at 37°C. Treated cells are washed with PBS and fresh DMEM is added. After a 16-18 hr recovery period, the culture is assayed for gene repair. The same oligonucleotide used in the cell-free extract experiments is used to target transfected plasmid bearing the kan^s gene. Correction of the point mutation in this gene eliminates a stop codon and restores full expression. This expression can be detected by adding a small non-fluorescent ligand that bound to a C-C-R-E-C-C sequence in the genetically modified carboxy terminus of the kan protein, to produce a highly fluorescent complex (FIAsH system, Aurora Biosciences Corporation). Following a 60 min incubation at room temperature with the ligand (FIAsH-EDT2), cells expressing full length kan product acquire an intense green fluorescence detectable by fluorescence microscopy using a fluorescein filter set. Similar experiments are performed using the HygeGFP target as described in Example 2 with a variety of mammalian cells, including, for example, COS-1 and COS-7 cells (African green monkey), and CHO-K1 cells (Chinese hamster ovary). The experiments are also performed with PG12 cells (rat pheochromocytoma) and ES cells (human embryonic stem cells).

Summary of experimental results. Tables 1, 2 and 3 respectively provide data on the efficiency of gene repair directed by single-stranded oligonucleotides. Table 1 presents data using a cell-free extract from human liver cells (HUH7) to catalyze repair of the point mutation in plasmid pkan^sm4021 (see Figure 1). Table 2 illustrates that the oligomers are not dependent on MSH2 or MSH3 for optimal gene repair activity. Table 3 illustrates data from the repair of a frameshift mutation (Figure 3) in the tet gene contained in plasmid pTetΔ208. Table 4 illustrates data from repair of the pkan^sm4021 point mutation catalyzed by plant cell extracts prepared from canola and musa (banana). Colony numbers are presented as kan^r or tet^r and fold increases (single strand versus double hairpin) are presented for kan^r in Table 1.

Figure 5A is a confocal picture of HeLa cells expressing the corrected fusion protein from an episomal target. Gene repair is accomplished by the action of a modified single-stranded oligonucleotide containing 3 phosphorothioate linkages at each end (3S/25G). Figure 5B represents a "Z-series" of HeLa cells bearing the corrected fusion gene. This series sections the cells from bottom to top and illustrates that the fluorescent signal is "inside the cells".

Results. In summary, we have designed a novel class of single-stranded oligonucleotides with backbone modifications at the termini and demonstrate gene repair/conversion

activity in mammalian and plant cell-free extracts. We confirm that the all DNA strand of the RNA-DNA double-stranded double hairpin chimera is the active component in the process of gene repair. In some cases, the relative frequency of repair by the novel oligonucleotides of the invention is elevated approximately 3-4-fold in certain embodiments when compared to frequencies directed by chimeric RNA-DNA double hairpin oligonucleotides.

This strategy centers around the use of extracts from various sources to correct a mutation in a plasmid using a modified single-stranded or a chimeric RNA-DNA double hairpin oligonucleotide. A mutation is placed inside the coding region of a gene conferring antibiotic resistance in bacteria, here kanamycin or tetracycline. The appearance of resistance is measured by genetic readout in *E.coli* grown in the presence of the specified antibiotic. The importance of this system is that both phenotypic alteration and genetic inheritance can be measured. Plasmid pK^sm4021 contains a mutation (T→G) at residue 4021 rendering it unable to confer antibiotic resistance in *E.coli*. This point mutation is targeted for repair by oligonucleotides designed to restore kanamycin resistance. To avoid concerns of plasmid contamination skewing the colony counts, the directed correction is from G→C rather than G→T (wild-type). After isolation, the plasmid is electroporated into the DH10B strain of *E.coli*, which contains inactive RecA protein. The number of kanamycin colonies is counted and normalized by ascertaining the number of ampicillin colonies, a process that controls for the influence of electroporation. The number of colonies generated from three to five independent reactions was averaged and is presented for each experiment. A fold increase number is recorded to aid in comparison.

The original RNA-DNA double hairpin chimera design, e.g., as disclosed in U.S. Patent 5,565,350, consists of two hybridized regions of a single-stranded oligonucleotide folded into a double hairpin configuration. The double-stranded targeting region is made up of a 5 base pair DNA/DNA segment bracketed by 10 base pair RNA/DNA segments. The central base pair is mismatched to the corresponding base pair in the target gene. When a molecule of this design is used to correct the kan^s mutation, gene repair is observed (I in Figure 1A). Chimera II (Figure 1B) differs partly from chimera I in that only the DNA strand of the double hairpin is mismatched to the target sequence. When this chimera was used to correct the kan^s mutation, it was twice as active. In the same study, repair function could be further increased by making the targeting region of the chimera a continuous RNA/DNA hybrid.

Frame shift mutations are repaired. By using plasmid pT^sΔ208, described in Figure 1(C) and Figure 3, the capacity of the modified single-stranded molecules that showed activity in correcting a point mutation, can be tested for repair of a frameshift. To determine efficiency of correction of the mutation, a chimeric oligonucleotide (Tet I), which is designed to insert a T residue at position 208, is

used. A modified single-stranded oligonucleotide (Tet IX) directs the insertion of a T residue at this same site. Figure 3 illustrates the plasmid and target bases designated for change in the experiments. When all reaction components are present (extract, plasmid, oligomer), tetracycline resistant colonies appear. The colony count increases with the amount of oligonucleotide used up to a point beyond which the count falls off (Table 3). No colonies above background are observed in the absence of either extract or oligonucleotide, nor when a modified single-stranded molecule bearing perfect complementarity is used. Figure 3 represents the sequence surrounding the target site and shows that a T residue is inserted at the correct site. We have isolated plasmids from fifteen colonies obtained in three independent experiments and each analyzed sequence revealed the same precise nucleotide insertion. These data suggest that the single-stranded molecules used initially for point mutation correction can also repair nucleotide deletions.

Comparison of phosphorothioate oligonucleotides to 2'-O-methyl substituted oligonucleotides. From a comparison of molecules VII and XI, it is apparent that gene repair is more subject to inhibition by RNA residues than by phosphorothioate linkages. Thus, even though both of these oligonucleotides contain an equal number of modifications to impart nuclease resistance, XI (with 16 phosphorothioate linkages) has good gene repair activity while VII (with 16 2'-O-methyl RNA residues) is inactive. Hence, the original chimeric double hairpin oligonucleotide enabled correction directed, in large part, by the strand containing a large region of contiguous DNA residues.

Oligonucleotides can target multiple nucleotide alterations within the same template. The ability of individual single-stranded oligonucleotides to correct multiple mutations in a single target template is tested using the plasmid pK^sm4021 and the following single-stranded oligonucleotides modified with 3 phosphorothioate linkages at each end (indicated as underlined nucleotides): Oligo1 is a 25-mer with the sequence TTCGATAAGCCTATGCTGACCCGTG corrects the original mutation present in the kanamycin resistance gene of pK^sm4021 as well as directing another alteration 2 basepairs away in the target sequence (both indicated in boldface); Oligo2 is a 70-mer with the 5'-end sequence TTCGGCTACGACTGGGCACAACAGACAATTGGC with the remaining nucleotides being completely complementary to the kanamycin resistance gene and also ending in 3 phosphorothioate linkages at the 3' end. Oligo2 directs correction of the mutation in pK^sm4021 as well as directing another alteration 21 basepairs away in the target sequence (both indicated in boldface).

We also use additional oligonucleotides to assay the ability of individual oligonucleotides to correct multiple mutations in the pK^sM4021 plasmid. These include, for example, a second 25-mer that alters two nucleotides that are three nucleotides apart with the sequence 5'-

TTGTGCCCAGTC**G**TA**I**CCGAATAGC-3'; a 70-mer that alters two nucleotides that are 21 nucleotides apart with the sequence 5'-CATCAGAGCAGCC**A**ATTGTCTGTTGTGCCCAGTC**G**TAGCCGAA TAGCCTCTCCACCCAAGCGGCCGGAGA-3'; and another 70-mer that alters two nucleotides that are 21 nucleotides apart with the sequence 5'-

5 GCTGACAGCCGGAACACGGCGGCATCAGAGCAGCC**A**ATTGTCTGTTGTGCCCAGTC**G**TAGCCGAAT AGCCT-3'. The nucleotides in the oligonucleotides that direct alteration of the target sequence are underlined and in boldface. These oligonucleotides are modified in the same way as the other oligonucleotides of the invention.

10 We assay correction of the original mutation in pK^m4021 by monitoring kanamycin resistance (the second alterations which are directed by Oligo2 and Oligo3 are silent with respect to the kanamycin resistance phenotype). In addition, in experiments with Oligo2, we also monitor cleavage of the resulting plasmids using the restriction enzyme Tsp509I which cuts at a specific site present only when the second alteration has occurred (at ATT in Oligo2). We then sequence these clones to determine whether the additional, silent alteration has also been introduced. The results of an analysis
15 are presented below:

	Oligo1 (25-mer)	Oligo2 (70-mer)
Clones with both sites changed	9	7
Clones with a single site changed	0	2
Clones that were not changed	4	1

20 *Nuclease sensitivity of unmodified DNA oligonucleotide.* Electrophoretic analysis of nucleic acid recovered from the cell-free extract reactions conducted here confirm that the unmodified single-stranded 25-mer did not survive incubation whereas greater than 90% of the terminally modified oligos did survive (as judged by photo-image analyses of agarose gels).

25 *Plant extracts direct repair.* The modified single-stranded constructs can be tested in plant cell extracts. We have observed gene alteration using extracts from multiple plant sources, including, for example, Arabidopsis, tobacco, banana, maize, soybean, canola, wheat, spinach as well as spinach chloroplast extract or extracts made from other plant cells disclosed herein. We prepare the extracts by grinding plant tissue or cultured cells under liquid nitrogen with a mortar and pestle. We extract 3 ml of the ground plant tissue with 1.5 ml of extraction buffer (20 mM HEPES, pH7.5; 5 mM KCl;

1.5 mM MgCl₂; 10 mM DTT; and 10% [v/v] glycerol). Some plant cell-free extracts also include about 1% (w/v) PVP. We then homogenize the samples with 15 strokes of a Dounce homogenizer. Following homogenization, we incubate the samples on ice for 1 hour and centrifuge at 3000 x g for 5 minutes to remove plant cell debris. We then determine the protein concentration in the supernatants (extracts) by
5 Bradford assay. We dispense 100 µg (protein) aliquots of the extracts which we freeze in a dry ice-ethanol bath and store at -80°C.

We describe experiments using two sources here: a dicot (canola) and a monocot (banana, *Musa acuminata* cv. Rasthali). Each vector directs gene repair of the kanamycin mutation (Table 4); however, the level of correction is elevated 2-3 fold relative to the frequency observed with the
10 chimeric oligonucleotide. These results are similar to those observed in the mammalian system wherein a significant improvement in gene repair occurred when modified single-stranded molecules were used.

Tables are attached hereto.

Table I

Gene repair activity is directed by single-stranded oligonucleotides.

Oligonucleotide	Plasmid	Extract (ug)	kan ^r colonies	Fold increase
I	pK ^s m4021	10	300	
I		20	418	1.0x
II		10	537	
II		20	748	1.78x
III		10	3	
III		20	5	0.01x
IV		10	112	
IV		20	96	0.22x
V		10	217	
V		20	342	0.81x
VI		10	6	
VI		20	39	0.093x
VII		10	0	
VII		20	0	0x
VIII		10	3	
VIII		20	5	0.01x
IX		10	936	
IX		20	1295	3.09x
X		10	1140	
X		20	1588	3.7x
XI		10	480	
XI		20	681	1.6x
XII		10	18	
XII		20	25	0.059x
XIII		10	0	
XIII		20	4	0.009x
-		20	0	
I		-	0	

Plasmid pK^sm4021 (1 µg), the indicated oligonucleotide (1.5 µg chimeric oligonucleotide or 0.55 µg single-stranded oligonucleotide; molar ratio of oligo to plasmid of 360 to 1) and either 10 or 20 µg of HUH7 cell-free extract were incubated 45 min at 37°C. Isolated plasmid DNA was electroporated into *E. coli* (strain DH10B) and the number of kan^r colonies counted. The data represent the number of kanamycin resistant colonies per 10⁶ ampicillin resistant colonies generated from the same reaction and is the average of three

experiments (standard deviation usually less than +/- 15%). Fold increase is defined relative to 418 kan^r colonies (second reaction) and in all reactions was calculated using the 20µg sample.

Table II

Modified single-stranded oligomers are not dependent on MSH2 or MSH3 for optimal gene repair activity.

A. Oligonucleotide	Plasmid	Extract	kan ^r colonies
IX (3S/25G)	↓	HUH7	637
X (6S/25G)		HUH7	836
IX		MEF2 ^{-/-}	781
X		MEF2 ^{-/-}	676
IX		MEF3 ^{-/-}	582
X		MEF3 ^{-/-}	530
IX		MEF ^{+/+}	332
X		MEF ^{+/+}	497
-		MEF2 ^{-/-}	10
-		MEF3 ^{-/-}	5
-		MEF ^{+/+}	14

Chimeric oligonucleotide (1.5 µg) or modified single-stranded oligonucleotide (0.55 µg)

was incubated with 1 µg of plasmid pK^m4021 and 20 µg of the indicated extracts. MEF

represents mouse embryonic fibroblasts with either MSH2 (2^{-/-}) or MSH3 (3^{-/-}) deleted.

MEF^{+/+} indicates wild-type mouse embryonic fibroblasts. The other reaction components

were then added and processed through the bacterial readout system. The data represent the

number of kanamycin resistant colonies per 10⁶ ampicillin resistant colonies.

Table III

Frameshift mutation repair is directed by single-stranded oligonucleotides

Oligonucleotide	Plasmid	Extract	tet ^r colonies
Tet IX (3S/25A; 0.5 µg)	pT ^r Δ208 (1µg)	-	0
	↓	20µg	0
Tet IX (0.5 µg)		↓	48
Tet IX (1.5 µg)			130
Tet IX (2.0 µg)			68
Tet I (chimera; 1.5 µg)	↓	↓	48

Each reaction mixture contained the indicated amounts of plasmid and oligonucleotide.

The extract used for these experiments came from HUH7 cells. The data represent the number of tetracycline resistant colonies per 10⁶ ampicillin resistant colonies generated from the same reaction and is the average of 3 independent experiments. Tet I is a chimeric oligonucleotide and Tet IX is a modified single-stranded oligonucleotide that are designed to insert a T residue at position 208 of pT^rΔ208. These oligonucleotides are equivalent to structures I and IX in Figure 2.

Table IV

Plant cell-free extracts support gene repair by single-stranded oligonucleotides

Oligonucleotide	Plasmid	Extract	kan ^r colonies
II (chimera)	pK ^S m4021	30µg Canola	337
IX (3S/25G)	↓	Canola	763
X (6S/25G)		Canola	882
II		Musa	203
IX		Musa	343
X		Musa	746
-		Canola	0
-		Musa	0
IX		- Canola	0
X		- Musa	0

Canola or Musa cell-free extracts were tested for gene repair activity on the kanamycin-sensitive gene as previously described in (18). Chimeric oligonucleotide II (1.5 µg) and modified single-stranded oligonucleotides IX and X (0.55µg) were used to correct pK^Sm4021. Total number of kan^r colonies are present per 10⁷ ampicillin resistant colonies and represent an average of four independent experiments.

Table V

Gene repair activity in cell-free extracts prepared from yeast (Saccharomyces cerevisiae)

Cell-type	Plasmid	Chimeric Oligo	SS Oligo	kan ^r /amp ^r x 10 ⁶
Wild type	pKan ^r m4021	1μg		0.36
Wild type	↓		1μg	0.81
ΔRAD52		1μg		10.72
ΔRAD52			1μg	17.41
ΔPMS1		1μg		2.02
ΔPMS1			1μg	3.23

In this experiment, the kan^r gene in pKan^rm4021 is corrected by either a chimeric double-hairpin oligonucleotide or a single-stranded oligonucleotide containing three thioate linkages at each end (3S/25G).

EXAMPLE 2

Yeast Cell Targeting Assay Method for Base Alteration and Preferred Oligonucleotide Selection

In this example, single-stranded oligonucleotides with modified backbones and double-hairpin oligonucleotides with chimeric, RNA-DNA backbones are used to measure gene repair using two episomal targets with a fusion between a hygromycin resistance gene and eGFP as a target for gene repair. These plasmids are pAURHYG(rep)GFP, which contains a point mutation in the hygromycin resistance gene (Figure 7), pAURHYG(ins)GFP, which contains a single-base insertion in the hygromycin resistance gene (Figure 7) and pAURHYG(Δ)GFP which has a single base deletion. We also use the plasmid containing a wild-type copy of the hygromycin-eGFP fusion gene, designated pAURHYG(wt)GFP, as a control. These plasmids also contain an aureobasidinA resistance gene. In pAURHYG(rep)GFP, hygromycin resistance gene function and green fluorescence from the eGFP protein are restored when a G at position 137, at codon 46 of the hygromycin B coding sequence, is converted to a C thus removing a premature stop codon in the hygromycin resistance gene coding region. In pAURHYG(ins)GFP, hygromycin resistance gene function and green fluorescence from the eGFP protein are restored when an A inserted between nucleotide positions 136 and 137, at codon 46 of the hygromycin B coding sequence, is deleted and a C is substituted for the T at position 137, thus correcting a frameshift mutation and restoring the reading frame of the hygromycin-eGFP fusion gene.

We synthesize the set of three yeast expression constructs pAURHYG(rep)eGFP, pAURHYG(Δ)eGFP, pAURHYG(ins)eGFP, that contain a point mutation at nucleotide 137 of the hygromycin-B coding sequence as follows. (rep) indicates a T137 \rightarrow G replacement, (Δ) represents a deletion of the G137 and (ins) represents an A insertion between nucleotides 136 and 137. We construct this set of plasmids by excising the respective expression cassettes by restriction digest from pHyg(x)EGFP and ligation into pAUR123 (Panvera, CA). We digest 10 μ g pAUR123 vector DNA, as well as, 10 μ g of each pHyg(x)EGFP construct with KpnI and Sall (NEB). We gel purify each of the DNA fragments and prepare them for enzymatic ligation. We ligate each mutated insert into pHygEGFP vector at 3:1 molar ratio using T4 DNA ligase (Roche). We screen clones by restriction digest, confirm by Sanger dideoxy chain termination sequencing and purify using a Qiagen maxiprep kit.

We use this system to assay the ability of five oligonucleotides (shown in Figure 8) to support correction under a variety of conditions. The oligonucleotides which direct correction of the mutation in pAURHYG(rep)GFP can also direct correction of the mutation in pAURHYG(ins)GFP. Three of the four oligonucleotides (HygE3T/25, HygE3T/74 and HygGG/Rev) share the same 25-base sequence surrounding the base targeted for alteration. HygGG/Rev is an RNA-DNA chimeric double hairpin

oligonucleotide of the type described in the prior art. One of these oligonucleotides, HygE3T/74, is a 74-base oligonucleotide with the 25-base sequence centrally positioned. The fourth oligonucleotide, designated HygE3T/74 α , is the reverse complement of HygE3T/74. The fifth oligonucleotide, designated Kan70T, is a non-specific, control oligonucleotide which is not complementary to the target sequence.

5 Alternatively, an oligonucleotide of identical sequence but lacking a mismatch to the target or a completely thioate modified oligonucleotide or a completely 2-O-methylated modified oligonucleotide may be used as a control. Alternatively, oligonucleotides containing one, two, three, four, five, six, eight, ten or more LNA modifications on at least one of the two termini (and preferably the 3' terminus) may be used in different embodiments.

10 *Oligonucleotide synthesis and cells.* We synthesized and purified the chimeric, double-hairpin oligonucleotides and single-stranded oligonucleotides (including those with the indicated modifications) as described in Example 1. Plasmids used for assay were maintained stably in yeast (*Saccharomyces cerevisiae*) strain LSY678 MAT α at low copy number under aureobasidin selection. Plasmids and oligonucleotides are introduced into yeast cells by electroporation as follows: to prepare
15 electrocompetent yeast cells, we inoculate 10 ml of YPD media from a single colony and grow the cultures overnight with shaking at 300 rpm at 30°C. We then add 30 ml of fresh YPD media to the overnight cultures and continue shaking at 30°C until the OD₆₀₀ was between 0.5 and 1.0 (3-5 hours). We then wash the cells by centrifuging at 4°C at 3000 rpm for 5 minutes and twice resuspending the cells in 25 ml ice-cold distilled water. We then centrifuge at 4°C at 3000 rpm for 5 minutes and resuspend in 1 ml
20 ice-cold 1M sorbitol and then finally centrifuge the cells at 4°C at 5000 rpm for 5 minutes and resuspend the cells in 120 μ l 1M sorbitol. To transform electrocompetent cells with plasmids or oligonucleotides, we mix 40 μ l of cells with 5 μ g of nucleic acid, unless otherwise stated, and incubate on ice for 5 minutes. We then transfer the mixture to a 0.2 cm electroporation cuvette and electroporate with a BIO-RAD Gene Pulser apparatus at 1.5 kV, 25 μ F, 200 Ω for one five-second pulse. We then immediately resuspend the
25 cells in 1 ml YPD supplemented with 1M sorbitol and incubate the cultures at 30°C with shaking at 300 rpm for 6 hours. We then spread 200 μ l of this culture on selective plates containing 300 μ g/ml hygromycin and spread 200 μ l of a 10⁵ dilution of this culture on selective plates containing 500 ng/ml aureobasidinA and/or and incubate at 30°C for 3 days to allow individual yeast colonies to grow. We then count the colonies on the plates and calculate the gene conversion efficiency by determining the number
30 of hygromycin resistance colonies per 10⁵ aureobasidinA resistant colonies.

Frameshift mutations are repaired in yeast cells. We test the ability of the oligonucleotides shown in Figure 8 to correct a frameshift mutation *in vivo* using LSY678 yeast cells

containing the plasmid pAURHYG(ins)GFP. These experiments, presented in Table 6, indicate that these oligonucleotides can support gene correction in yeast cells. These data reinforce the results described in Example 1 indicating that oligonucleotides comprising phosphorothioate linkages facilitate gene correction much more efficiently than control duplex, chimeric RNA-DNA oligonucleotides. This gene correction activity is also specific as transformation of cells with the control oligonucleotide Kan70T produced no hygromycin resistant colonies above background and thus Kan70T did not support gene correction in this system. In addition, we observe that the 74-base oligonucleotide (HygE3T/74) corrects the mutation in pAURHYG(ins)GFP approximately five-fold more efficiently than the 25-base oligonucleotide (HygE3T/25). We also perform control experiments with LSY678 yeast cells containing the plasmid pAURHYG(wt)GFP. With this strain we observed that even without added oligonucleotides, there are too many hygromycin resistant colonies to count.

We also use additional oligonucleotides to assay the ability of individual oligonucleotides to correct multiple mutations in the pAURHYG(x)eGFP plasmid. These include, for example, one that alters two basepairs that are 3 nucleotides apart is a 74-mer with the sequence 5'-

CTCGTGCTTTCAGCTTCGATGTAGGAGGGCGTGG**G**TAC**G**TCCTGCGGGTAAATAGCTGCGCCGATG
GTTTCTAC-3'; a 74-mer that alters two basepairs that are 15 nucleotides apart with the sequence 5'-
CTCGTGCTTTCAGCTTCGATGTAGGAGGGCGTGGATAC**G**TCCTGCGGGTAAAC**A**AGCTGCGCCGATG
GTTTCTAC-3'; and a 74-mer that alters two basepairs that are 27 nucleotides apart with the sequence 5'-
CTCGTGCTTTCAGCTTCGATGTAGGAGGGCGTGGATAC**G**TCCTGCGGGTAAATAGCTGCGCCG**A**C**G**
GTTTCTAC. The nucleotides in these oligonucleotides that direct alteration of the target sequence are underlined and in boldface. These oligonucleotides are modified in the same ways as the other oligonucleotides of the invention.

Oligonucleotides targeting the sense strand direct gene correction more efficiently. We compare the ability of single-stranded oligonucleotides to target each of the two strands of the target sequence of both pAURHYG(ins)GFP and pAURHYG(rep)GFP. These experiments, presented in Tables 7 and 8, indicate that an oligonucleotide, HygE3T/74 α , with sequence complementary to the sense strand (i.e. the strand of the target sequence that is identical to the mRNA) of the target sequence facilitates gene correction approximately ten-fold more efficiently than an oligonucleotide, HygE3T/74, with sequence complementary to the non-transcribed strand which serves as the template for the synthesis of RNA. As indicated in Table 7, this effect was observed over a range of oligonucleotide concentrations from 0-3.6 μ g, although we did observe some variability in the difference between the two oligonucleotides (indicated in Table 7 as a fold difference between HygE3T/74 α and HygE3T/74).

Furthermore, as shown in Table 8, we observe increased efficiency of correction by HygE3T/74 α relative to HygE3T/74 regardless of whether the oligonucleotides were used to correct the base substitution mutation in pAURHYG(rep)GFP or the insertion mutation in pAURHYG(ins)GFP. The data presented in Table 8 further indicate that the single-stranded oligonucleotides correct a base substitution mutation more efficiently than an insertion mutation. However, this last effect was much less pronounced and the oligonucleotides of the invention are clearly able efficiently to correct both types of mutations in yeast cells. In addition, the role of transcription is investigated using plasmids with inducible promoters such as that described in Figure 10.

Optimization of oligonucleotide concentration. To determine the optimal concentration of oligonucleotide for the purpose of gene alteration, we test the ability of increasing concentrations of Hyg3T/74 α to correct the mutation in pAURHYG(rep)GFP contained in yeast LSY678. We chose this assay system because our previous experiments indicated that it supports the highest level of correction. However, this same approach could be used to determine the optimal concentration of any given oligonucleotide. We test the ability of Hyg3T/74 α to correct the mutation in pAURHYG(rep)GFP contained in yeast LSY678 over a range of oligonucleotide concentrations from 0-10.0 μ g. As shown in Table 9, we observe that the correction efficiency initially increases with increasing oligonucleotide concentration, but then declines at the highest concentration tested.

Tables are attached hereto.

Table 6

Correction of an insertion mutation in pAURHYG(ins)GFP by HygGG/Rev, HygE3T/25 and HygE3T/74

Oligonucleotide Tested	Colonies on Hygromycin	Colonies on Aureobasidin (/10 ⁶)	Correction Efficiency
HygGG/Rev	3	157	0.02
HygE3T/25	64	147	0.44
HygE3T/74	280	174	1.61
Kan70T	0	—	—

Table 7

An oligonucleotide targeting the sense strand of the target sequence corrects more efficiently.

Amount of Oligonucleotide (μg)	Colonies per hygromycin plate	
	HygE3T/74	HygE3T/74α
0	0	0
0.6	24	128 (8.4x)*
1.2	69	140 (7.5x)*
2.4	62	167 (3.8x)*
3.6	29	367 (15x)*

* The numbers in parentheses represent the fold increase in efficiency for targeting the non-transcribed strand as compared to the other strand of a DNA duplex that encodes a protein.

Table 8

Correction of a base substitution mutation is more efficient than correction of a frame shift mutation.

Oligonucleotide Tested (5 µg)	Plasmid tested (contained in LSY678)	
	pAURHYG(ins)GFP	pAURHYG(rep)GFP
HygE3T/74	72	277
HygE3T/74α	1464	2248
Kan70T	0	0

Table 9

Optimization of oligonucleotide concentration in electroporated yeast cells.

Amount (µg)	Colonies on hygromycin	Colonies on aureobasidin (/10 ⁵)	Correction efficiency
0	0	67	0
1.0	5	64	0.08
2.5	47	30	1.57
5.0	199	33	6.08
7.5	383	39	9.79
10.0	191	33	5.79

Example 3 Cultured Cell Manipulation

Although disclosure in this example is directed to use of stem cells or human blood cells and microinjection, the microinjection procedures may also be used with cultured plant cells or protoplasts using any plant species, including those disclosed herein. Mononuclear cells are isolated from human umbilical cord blood of normal donors using Ficoll Hypaque (Pharmacia Biotech, Uppsala, Sweden) density centrifugation. CD34+ cells are immunomagnetically purified from mononuclear cells using either

the progenitor or Multisort Kits (Miltenyi Biotec, Auburn, CA). Lin⁻CD38⁻ cells are purified from the mononuclear cells using negative selection with StemSep system according to the manufacturer's protocol (Stem Cell Technologies, Vancouver, CA). Cells used for microinjection are either freshly isolated or cryopreserved and cultured in Stem Medium (S Medium) for 2 to 5 days prior to microinjection.

5 S Medium contains Iscoves' Modified Dulbecco's Medium without phenol red (IMDM) with 100 µg/ml glutamine/penicillin/streptomycin, 50 mg/ml bovine serum albumin, 50 µg/ml bovine pancreatic insulin, 1 mg/ml human transferrin, and IMDM; Stem Cell Technologies), 40 µg/ml low-density lipoprotein (LDL; Sigma, St. Louis, MO), 50 mM HEPES buffer and 50 µM 2-mercaptoethanol, 20 ng/ml each of thrombopoietin, flt-3 ligand, stem cell factor and human IL-6 (Pepro Tech Inc., Rocky Hill, NJ). After
10 microinjection, cells are detached and transferred in bulk into wells of 48 well plates for culturing.

35 mm dishes are coated overnight at 4° C with 50 µg/ml Fibronectin (FN) fragment CH-296 (Retronectin; TaKaRa Biomedicals, Panvera, Madison, WI) in phosphate buffered saline and washed with IMDM containing glutamine/penicillin/streptomycin. 300 to 2000 cells are added to cloning rings and attached to the plates for 45 minutes at 37° C prior to microinjection. After incubation, cloning rings are
15 removed and 2 ml of S Medium are added to each dish for microinjection. Pulled injection needles with a range of 0.22 µm to 0.3 µm outer tip diameter are used. Cells are visualized with a microscope equipped with a temperature controlled stage set at 37° C and injected using an electronically interfaced Eppendorf Micromanipulator and Transjector. Successfully injected cells are intact, alive and remain attached to the plate post injection. Molecules that are fluorescently labeled allow determination of the amount of
20 oligonucleotide delivered to the cells.

For *in vitro* erythropoiesis from Lin⁻CD38⁻ cells, the procedure of Malik, 1998 can be used. Cells are cultured in ME Medium for 4 days and then cultured in E Medium for 3 weeks. Erythropoiesis is evident by glycophorin A expression as well as the presence of red color representing the presence of hemoglobin in the cultured cells. The injected cells are able to retain their proliferative
25 capacity and the ability to generate myeloid and erythroid progeny. CD34⁺ cells can convert a normal A (β^A) to sickle T (β^S) mutation in the β-globin gene or can be altered using any of the oligonucleotides of the invention herein for correction or alteration of a normal gene to a mutant gene. Alternatively, stem cells can be isolated from blood of humans having genetic disease mutations and the oligonucleotides of the invention can be used to correct a defect or to modify genomes within those cells.

30 Alternatively, non-stem cell populations of cultured cells can be manipulated using any method known to those of skill in the art including, for example, the use of polycations, cationic lipids,

liposomes, polyethylenimine (PEI), electroporation, biolistics, calcium phosphate precipitation, or any other method known in the art.

Biolistic delivery of oligonucleotide into plant cells may be accomplished according to the following method. One milliliter of packed cell volume of plant cell suspensions are subcultured onto plates containing solid medium [with Murashige and Skoog salts from Gibco/BRL, 500 mg/liter Mes, 1 mg/liter thiamin, 100 mg/liter myo-inositol, 180 mg/liter KH_2PO_4 , 2.21 mg/liter 2,4-dichlorophenoxyacetic acid (2,4-D), and 30 g/liter sucrose (pH 5.7) and having 8 g/liter agar-agar from Sigma added before autoclaving]. By using a helium-driven particle gun such as that from BioRad and following manufacturers directions, oligonucleotides may be introduced to cells after precipitation onto 1 micrometer or comparable gold microcarriers (Bio-Rad). To precipitate onto microcarriers, 35 microliters of a particle suspension (60 mg of microcarriers per ml of 100% ethanol) is transferred to a 1.5 ml microcentrifuge tube, which is agitated on a vortex mixer. Then 40 microliter of resuspended oligonucleotide (60 ng/microliter water) is added; then 75 microliter of ice-cold 2.5 M CaCl_2 is added; then 75 microliter of ice-cold 0.1 M spermidine is added. The tube is mixed vigorously on a vortex mixer for 10 min at room temperature. The particles are allowed to settle for 10 min and are centrifuged at 11,750 g for 30 sec. The supernatant is removed and the particles are resuspended in 50 microliter of 100% ethanol. An aliquot of 10 microliter of the resuspended particles are applied to each macro-projectile which is used to bombard each plate once at 900 psi (1 psi = 6.89 kPa) with a gap distance (distance from power source to macroprojectile) of 1 cm and a target distance (distance from microprojectile launch site to target material) of 10 cm.

An alternative method of delivery can be used as follows. Cultured cells are suspended in liquid N6 medium and then plated on a VWR Scientific glass fiber filter. About 0.4 microgram of oligonucleotide are precipitated with 15 microliter of 2.5 mM CaCl_2 and 5 microliter of 0.1 M spermidine onto 25 microgram of 1.0 micrometer gold particles. Microprojectile bombardment is performed by using a Bio-Rad PDS-1000 He particle delivery system or comparable machine following manufacturers instructions. Alterations in oligonucleotide concentrations can be employed to determine the optimum concentration of oligonucleotide according to the procedures described herein for any particular oligonucleotide of the invention.

Alternatively, the oligonucleotide of the invention may be delivered to a plant cell by electroporation of a protoplast derived from a plant part. The protoplasts may be formed by enzymatic treatment of a plant part, particularly a leaf, according to techniques such as those in Gallois et al., Methods in Molecular Biology 55: 89-107 by Humana Press. Such conditions for electroporation use

about 3×10^5 protoplasts in a total volume of about 0.3 ml with a concentration of oligonucleotide of between 0.6 to 4 microgram per ml.

EXAMPLE 4

Plant Cells

5 The oligonucleotides of the invention can also be used to repair or direct a mutagenic event in plants and animal cells. Although little information is available on plant mutations amongst natural cultivars, the oligonucleotides of the invention can be used to produce "knock out" mutations by modification of specific amino acid codons to produce stop codons (e.g., a CAA codon specifying Gln can be modified at a specific site to TAA; a AAG codon specifying Lys can be modified to UAG at a specific
10 site; and a CGA codon for Arg can be modified to a UGA codon at a specific site). Such base pair changes will terminate the reading frame and produce a defective truncated protein, shortened at the site of the stop codon

 Alternatively, frameshift additions or deletions can be directed into the genome at a specific sequence to interrupt the reading frame and produce a garbled downstream protein. Such stop or frameshift mutations
15 can be introduced to determine the effect of knocking out the protein in either plant or animal cells.

 For introduction of a T-DNA, including the T-DNA in the plasmid of Figure 11, into a plant cell, *Agrobacterium tumefaciens* is used. These techniques are routine standard techniques known in the art. For example, one method follows. We transform *A. tumefaciens* is transformed by electroporation (using a BioRad Gene Pulser[™]). Competent *A. tumefaciens* is prepared using a method similar to that of
20 preparing competent *E. coli* by suspending a freshly grown culture three times in ice-cold water and a final resuspension in 10% glycerol. Electroporation conditions are a 0.2 cm gap cuvette at a setting of 25 μ F, 200 Ω and 2.5 kV.

A. tumefaciens containing a plasmid with a T-DNA is then used to introduce the T-DNA into a plant cell using routine standard techniques known in the art. For example, we transform
25 Arabidopsis by vacuum infiltration or by dipping flowers in an Agrobacterium solution containing a surfactant, e.g. L-77. Seeds are then collected, grown and screened for presence of the T-DNA. Alternatively, Agrobacterium can be used to transform callus tissue and the callus tissue can then be used to regenerate transformed plants.

 All publications and patent applications cited in this specification are herein incorporated
30 by reference as if each individual publication or patent application were specifically and individually indicated to be incorporated by reference. Although the foregoing invention has been described in some

detail by way of illustration and example for purposes of clarity of understanding, it will be readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of the appended claims.

5 **Notes on the tables presented below:**

Each of the following tables presents, for the specified gene, a plurality of mutations that are known to confer a relevant phenotype and, for each mutation, the oligonucleotides that can be used to correct the respective mutation site-specifically in the genome according to the present invention.

10 The left-most column identifies each alteration or mutation and the phenotype that the alteration/mutation confers.

For most entries, the mutation/alteration is identified at both the nucleic acid and protein level. At the amino acid level, mutations are presented according to the following standard nomenclature. The centered number identifies the position of the mutated codon in the protein sequence; to the left of the number is the wild type residue and to the right of the number is the mutant codon. Terminator codons are shown as "TERM". At the nucleic acid level, the entire triplet of the wild type and mutated codons is shown.

15 The middle column presents, for each mutation, four oligonucleotides capable of repairing the mutation site-specifically in the genome or in cloned DNA including DNA in artificial chromosomes, episomes, plasmids, or other types of vectors. The oligonucleotides of the invention, however, may include any of the oligonucleotides sharing portions of the sequence of the 121 base sequence. Thus, oligonucleotides of the invention for each of the depicted targets may be 18, 19, 20 up to about 121 nucleotides in length. Sequence may be added non-symmetrically.

20 All oligonucleotides are presented, per convention, in the 5' to 3' orientation. The nucleotide that effects the change in the genome is underlined and presented in bold.

25 The first of the four oligonucleotides for each mutation is a 121 nt oligonucleotide centered about the repair/altering nucleotide. The second oligonucleotide, its reverse complement, targets the opposite strand of the DNA duplex for repair/alteration. The third oligonucleotide is the minimal 17 nt domain of the first oligonucleotide, also centered about the repair/alteration nucleotide. The fourth oligonucleotide is the reverse complement of the third, and thus represents the minimal 17 nt domain of the second.

30 The third column of each table presents the SEQ ID NO: of the respective repair oligonucleotide.

Example 5**Engineering herbicide resistant plants**

Chemical weed control is an important tool of modern agriculture and many herbicides have been developed for this purpose. Their use has resulted in substantial increases in the yields of many crops, including, for example, maize, soybeans, and cotton. Thus while the use of fertilizers and new high-yielding crop varieties have contributed greatly to the "green revolution," chemical weed control has also been at the forefront of technological achievement.

Herbicides having broad-spectrum activity are particularly useful because they obviate the need for multiple herbicides targeting different classes of weeds. The problem with such herbicides is that they typically also affect crops which are exposed to the herbicide. One way to overcome this is to generate plants which are resistant to one or more broad-spectrum herbicides. Such herbicide-tolerant plants may reduce the need for tillage to control weeds, thereby effectively reducing soil erosion and can reduce the quantity and number of different herbicides applied in the field.

Common herbicides used, for example, include those that inhibit the enzyme 5-enolpyruvyl-3-phosphoshikimic acid synthase (EPSPS), for example N-phosphonomethyl-glycine (e.g. glyphosate), those that inhibit acetolactate synthase (ALS) activity, for example the sulfonyleureas and related herbicides, and those that inhibit dihydropteroate synthase, for example methyl[(4-amino-phenyl)sulfonyl]carbamate (e.g. Asulam). Herbicide-tolerant plants can be produced by several methods, including, for example, introducing into the genome of the plant the ability to degrade the herbicide, the capacity to produce a higher level of the targeted enzyme, and/or expressing an herbicide-tolerant allele of the enzyme.

The attached tables disclose exemplary oligonucleotides base sequences which can be used to generate site-specific mutations in plant genes that confer herbicide resistance.

Table 10
Genome-Altering Oligos Conferring Glyphosate Resistance

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Glyphosate Resistance EPSPS <i>Arabidopsis thaliana</i> Gly97Ala GGC-GCC	AAGCGTCGGAGATTGTA ^{CTT} CAACCCATTAGAGAAATCTCCGGTC TTATTAAGCTTCCTG ^{CCT} CCAAGTCTCTATCAAATCGGATCCTGC TTCTCGCTGCTCTGTCTGAGGTATATATCAC	4341
	GTGATATATACCTCAGACAGAGCAGCGAGAAGCAGGATCCGATT TGATAGAGACTTGGAG ^G CAGGAAGCTTAATAAGACCGGAGATTT CTCTAATGGGTTGAAGTACAATCTCCGACGCTT	4342
	GCTTCCTG ^{CCT} CCAAGT	4343
	ACTTGGAG ^G CAGGAAGC	4344
10 Glyphosate Resistance EPSPS <i>Brassica napus</i> Gly93Ala GGA-GCA	AAGCTTCAGAGATTGTGCTTCAACCAATCAGAGAAATCTCGGGTC TCATTAAGCTACCCG ^{CAT} CCAAATCTCTCTCCAATCGGATCCTCC TTCTTGCCGCTCTATCTGAGGTACATATACT	4345
	AGTATATGTACCTCAGATAGAGCGGCAAGAAGGAGGATCCGATT GGAGAGAGATTTGGAT ^G CGGGTAGCTTAATGAGACCCGAGATTT CTCTGATTGGTTGAAGCACAATCTCTGAAGCTT	4346
	GCTACCCG ^{CAT} CCAAAT	4347
	ATTTGGAT ^G CGGGTAGC	4348
15 Glyphosate Resistance EPSPS 1 <i>Nicotiana tabacum</i> Gly95Ala GGT-GCT	AGCCCAACGAGATTGTGCTGCAACCCATCAAAGATATATCAGGC ACTGTTAAATTGCCTG ^{CCT} TCTAAATCCCTTTCCAATCGTATTCTCC TTCTTGCTGCCCTTTCTAAGGGAAGGACTGT	4349
	ACAGTCCTTCCCTTAGAAAGGGCAGCAAGAAGGAGAATACGATT GGAAAGGGATTTAGAA ^G CAGGCAATTTAACAGTGCCTGATATATC TTTGATGGGTTGCAGCACAATCTCGTTGGGCT	4350
	ATTGCCTG ^{CCT} TCTAAAT	4351
	ATTTAGAA ^G CAGGCAAT	4352
20 Glyphosate Resistance EPSPS 2 <i>Nicotiana tabacum</i> Gly62Ala GGA-GCA	ATTGTTTCCTTGGTACGAAATGTCTCCTGTTCTGAATTGTCAGCA AGGGAGGCCTTCCCG ^C AGGGAAGGTAAAGCTCTCTGGATCAATT AGCAGCCAGTACTTGACTGCTCTGCTTATGGC	4353
	GCCATAAGCAGAGCAGTCAAGTACTGGCTGCTAATTGATCCAGA GAGCTTTACCTTCCCT ^G CGGGAAGGCCTCCCTTGCTGACAATTC GAACAGGAGGACATTTCTGTACCAAGGAAACAAT	4354
	CCTTCCCG ^C AGGGAAGG	4355
	CCTTCCCT ^G CGGGAAGG	4356
25 Glyphosate Resistance EPSPS <i>Zea mays</i> Gly168Ala GGT-GCT	ATTGTTTCCTTGGCACTGACTGCCACCTGTTCTGTGTAATGGAA TCGGAGGGCTACCTG ^{CCT} TGGCAAGGTCAAGCTGTCTGGCTCCATC AGCAGTCAGTACTTGAGTGCCTTGCTGATGGC	4357
	GCCATCAGCAAGGCACTCAAGTACTGACTGCTGATGGAGCCAGA CAGCTTGACCTTGCCAG ^C CAGGTAGCCCTCCGATTCCATTGACAC GAACAGGTGGGCAGTCAGTGCCAAGGAAACAAT	4358

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GCTACCTGCTGGCAAGG	4359
	CCTTGCCAGCAGGTAGC	4360
5 Glyphosate Resistance EPSPS <i>Oryza sativa</i> Gly115Ala GGT-GCT	ACTGTTTCCTTGGCACTGAATGCCCACCTGTTTCGTGTCAAGGGA ATTGGAGGACTTCCTGCTGGCAAGGTTAAGCTCTCTGGTCCAT CAGCAGTCAGTACTTGAGTGCCTTGCTGATGGC	4361
	GCCATCAGCAAGGCACTCAAGTACTGACTGCTGATGGAACCAGA GAGCTTAACCTTGCCAGCAGGAAGTCCTCCAATCCCTTGACAC GAACAGGTGGGCATTCACTGCCAAGGAAACAGT	4362
	ACTTCCTGCTGGCAAGG	4363
	CCTTGCCAGCAGGAAGT	4364
10 Glyphosate Resistance EPSPS <i>Petunia x hybrida</i> Gly93Ala GGC-GCC	AGCCTTCTGAGATAGTGTTGCAACCCATTAAAGAGATTTCAAGGCA CTGTAAATTGCCTGCCTCTAAATCATTATCTAATAGAATTCTCCT TCTTGCTGCCCTTATCTGAAGGAACAACACTGT	4365
	ACAGTTGTTCCCTCAGATAAGGCAGCAAGAAGGAGAATTCTATTA GATAATGATTTAGAGGCAGGCAATTTAACAGTGCCTGAAATCTCT TTAATGGGTTGCAACACTATCTCAGAAGGCT	4366
	ATTGCCTGCCTCTAAAT	4367
	ATTTAGAGGCAGGCAAT	4368
15 Glyphosate Resistance EPSPS <i>Lycopersicon esculentum</i> Gly97Ala GGT-GCT	AACCCCATGAGATTGTGCTAGNACCCATCAAAGATATATCTGGTA CTGTAAATTACCCGCTTCGAAATCCCTTTCCAATCGTATTCTCCT TCTTGCTGCCCTTTCTGAGGGAAGGACTGT	4369
	ACAGTCCTTCCCTCAGAAAGGGCAGCAAGAAGGAGAATACGATT GGAAAGGGATTTGGAAGCGGGTAATTTAACAGTACCAGATATATC TTTGATGGGTNCTAGCACAATCTCATGGGGTT	4370
	ATTACCCGCTTCGAAAT	4371
	ATTTGGAAGCGGGTAAT	4372
20 Glyphosate Resistance EPSPS <i>Lolium rigidum</i> Gly107Ala GGT-GCT	ATTGTTTCCTTGGCACTGACTGCCCACCTGTTTCGKATCAACGGCA TTGGAGGGCTACCTGCTGGCAAGGTTAAGCTGTCTGGTCCATC AGCAGCCAATACTTGAGTTCCTTGCTGATGGC	4373
	GCCATCAGCAAGGAACTCAAGTATTGGCTGCTGATGGAACCAGA CAGCTTAACCTTGCCAGCAGGTAGCCCTCCAATGCCGTTGATCG AACAGGTGGGCAGTCAGTGCCAAGGAAACAAT	4374
	GCTACCTGCTGGCAAGG	4375
	CCTTGCCAGCAGGTAGC	4376

Table 11
Genome-Altering Oligos Conferring Imidazolinone and Sulfonylurea Herbicide Resistance

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 10 Sulfonylurea Resistance ALS <i>Arabidopsis thaliana</i> Pro197Ser CCT-TCT	AGCGGATTAGCCGATGCGTTGTTAGATAGTGTTCTCTTGTAGCA ATCACAGGACAAGTCTCTCGTCGTATGATTGGTACAGATGCGTTT CAAGAGACTCCGATTGTTGAGGTAACGCGTT	4377
	AACGCGTTACCTCAACAATCGGAGTCTCTTGAAACGCATCTGTAC CAATCATACGACGAGAGACTTGTCCTGTGATTGCTACAAGAGGAA CACTATCTAACAACGCATCGGCTAATCCGCT	4378
	GACAAGTCTCTCGTCGT	4379
	ACGACGAGAGACTTGTC	4380
15 Sulfonylurea Resistance ALS <i>Arabidopsis thaliana</i> Pro197Gln CCT-CAG	AGCGGATTAGCCGATGCGTTGTTAGATAGTGTTCTCTTGTAGCA ATCACAGGACAAGTCCAGCGTCGTATGATTGGTACAGATGCGTTT CAAGAGACTCCGATTGTTGAGGTAACGCGTT	4381
	AACGCGTTACCTCAACAATCGGAGTCTCTTGAAACGCATCTGTAC CAATCATACGACGCTGGACTTGTCCTGTGATTGCTACAAGAGGAA CACTATCTAACAACGCATCGGCTAATCCGCT	4382
	ACAAGTCCAGCGTCGTC	4383
	TACGACGCTGGACTTGT	4384
20 Sulfonylurea Resistance ALS <i>Arabidopsis thaliana</i> Pro197Gln CCT-CAA	AGCGGATTAGCCGATGCGTTGTTAGATAGTGTTCTCTTGTAGCA ATCACAGGACAAGTCCAAACGTCGTATGATTGGTACAGATGCGTTT CAAGAGACTCCGATTGTTGAGGTAACGCGTT	4385
	AACGCGTTACCTCAACAATCGGAGTCTCTTGAAACGCATCTGTAC CAATCATACGACGTTGGACTTGTCCTGTGATTGCTACAAGAGGAA CACTATCTAACAACGCATCGGCTAATCCGCT	4386
	ACAAGTCCAAACGTCGTA	4387
	TACGACGTTGGACTTGT	4388
25 Imidazolinone Resistance ALS <i>Arabidopsis thaliana</i> Ser653Asn AGT-AAC	GACCTTACCTGTTGGATGTGATTTGTCCGCACCAAGAACATGTGT TGCCGATGATCCCGAACGGTGGCACTTTCAACGATGTCATAACGG AAGGAGATGGCCGGATTAAATACTGAGAGAT	4389
	ATCTCTCAGTATTTAATCCGGCCATCTCCTCCGTTATGACATCGT TGAAAGTGCCACCGTTCCGGGATCATCGGCAACACATGTTCTTGGT GCGGACAAATCACATCCAACAGGTAAGGTC	4390
	GATCCCGAACGGTGGCA	4391
	TGCCACCGTTCCGGATC	4392

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Imidazolinone Resistance ALS <i>Arabidopsis thaliana</i> Ser653Asn AGT-AAT	GACCTTACCTGTTGGATGTGATTTGTCCGCACCAAGAACATGTGT TGCCGATGATCCCGAATGGTGGCACTTTCAACGATGTCATAACGG AAGGAGATGGCCGGATTAAATACTGAGAGAT	4393
	ATCTCTCAGTATTTAATCCGGCCATCTCCTTCCGTTATGACATCGT TGAAAGTGCCACCATTCTGGGATCATCGGCAACACATGTTCTTGGT GCGGACAAATCACATCCAACAGGTAAGGTC	4394
	GATCCCGAATGGTGGCA	4395
	TGCCACCATTCTGGGATC	4396
10 Sulfonylurea Resistance ALS <i>Oryza sativa</i> Pro171Ser CCC-TCC	TCCGCGCTCGCCGACGCGCTGCTCGACTCCGTCCCGATGGTCG CCATCACGGGGCCAGGTCTCCCGCCGCATGATCGGCACCGACGC CTTCCAGGAGACGCCCATAGTCGAGGTCAACCGCT	4397
	AGCGGGTGACCTCGACTATGGGCGTCTCCTGGAAGGCGTCGGTG CCGATCATGCGGCGGGAGACCTGGCCCGTGATGGCGACCATCG GGACGGAGTCGAGCAGCGCGTCGGCGAGCGCGGA	4398
	GCCAGGCTCTCCCGCCGC	4399
	GCGGCGGGAGACCTGGC	4400
15 Sulfonylurea Resistance ALS <i>Oryza sativa</i> Pro171Gln CCC-CAA	CCGCGCTCGCCGACGCGCTGCTCGACTCCGTCCCGATGGTCGC CATCACGGGGCCAGGTCCAACGCCGCATGATCGGCACCGACGCC TTCCAGGAGACGCCCATAGTCGAGGTCAACCGCTC	4401
	GAGCGGGTGACCTCGACTATGGGCGTCTCCTGGAAGGCGTCGGT GCCGATCATGCGGCGTTGGACCTGGCCCGTGATGGCGACCATCG GGACGGAGTCGAGCAGCGCGTCGGCGAGCGCGG	4402
	CCAGGTCCAACGCCGCA	4403
	TGCGGCGTTGGACCTGG	4404
20 Sulfonylurea Resistance ALS <i>Oryza sativa</i> Pro171Gln CCC-CAG	CCGCGCTCGCCGACGCGCTGCTCGACTCCGTCCCGATGGTCGC CATCACGGGGCCAGGTCCAAGCGCCGCATGATCGGCACCGACGCC TTCCAGGAGACGCCCATAGTCGAGGTCAACCGCTC	4405
	GAGCGGGTGACCTCGACTATGGGCGTCTCCTGGAAGGCGTCGGT GCCGATCATGCGGCGTTGGACCTGGCCCGTGATGGCGACCATC GGGACGGAGTCGAGCAGCGCGTCGGCGAGCGCGG	4406
	CCAGGTCCAAGCGCCGCA	4407
	TGCGGCGCTGGACCTGG	4408
25 Imidazolinone Resistance ALS <i>Oryza sativa</i> Ile627Asn ATT-AAT	GGCCATACTTGTGGATATCATCGTCCCGCACCAGGAGCATGTGC TGCCATGATCCCAAATGGGGGCGCATTCAAGGACATGATCCTGG ATGGTGATGGCAGGACTGTGTATTAATCTAT	4409
	ATAGATTAATACACAGTCCTGCCATCACCATCCAGGATCATGTCCT TGAATGCGCCCCCAATTGGGATCATAGGCAGCACATGCTCCTGGT GCGGGACGATGATATCCAACAAGTATGGCC	4410
	GATCCCAAATGGGGGCG	4411

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CGCCCCCA <u>T</u> TTGGGATC	4412
5 Sulfonylurea Resistance ALS <i>Zea mays</i> Pro165Ser CCG-TCG	TCCGCGCTCGCCGACGCGCTGCTCGATTCCGTCCCCATGGTCGC CATCACGGGACAGGTG <u>T</u> CGCGACGCATGATTGGCACCAGCGCCT TCCAGGAGACGCCCATCGTCGAGGTCACCCGCT	4413
	AGCGGGTGACCTCGACGATGGGCGTCTCCTGGAAGGCGTCGGT GCCAATCATGCGTCGCGA <u>A</u> CACCTGTCCCGTGATGGCGACCATGG GGACGGAATCGAGCAGCGCGTCGGCGAGCGCGGA	4414
	GACAGGTG <u>T</u> CGCGACGC	4415
	GCGTCGCGA <u>A</u> CACCTGTC	4416
10 Sulfonylurea Resistance ALS <i>Zea mays</i> Pro165Gln CCG-CAG	CCGCGCTCGCCGACGCGCTGCTCGATTCCGTCCCCATGGTCGCC ATCACGGGACAGGTGC <u>A</u> GCGACGCATGATTGGCACCAGCGCCTT CCAGGAGACGCCCATCGTCGAGGTCACCCGCTC	4417
	GAGCGGGTGACCTCGACGATGGGCGTCTCCTGGAAGGCGTCGG TGCCAATCATGCGTCGCG <u>T</u> GACCTGTCCCGTGATGGCGACCATG GGGACGGAATCGAGCAGCGCGTCGGCGAGCGCGG	4418
	ACAGGTGC <u>A</u> GCGACGCA	4419
	TGCGTCGCTG <u>C</u> ACCTGT	4420
15 Imidazolinone Resistance ALS <i>Zea mays</i> Ser621Asn AGT-AAT	GGCCGTACCTCTTGGATATAATCGTCCCACACCAGGAGCATGTGT TGCCTATGATCCCTA <u>A</u> TGGTGGGGCTTTCAAGGATATGATCCTGG ATGGTGATGGCAGGACTGTGTACTGATCTAA	4421
	TTAGATCAGTACACAGTCCTGCCATCACCATCCAGGATCATATCCT TGAAAGCCCCACC <u>A</u> TAGGGATCATAGGCAACACATGCTCCTGGT GTGGGACGATTATATCCAAGAGGTACGGCC	4422
	GATCCCTA <u>A</u> TGGTGGGG	4423
	CCCCACC <u>A</u> TAGGGATC	4424
20 Imidazolinone Resistance ALS <i>Zea mays</i> Ser621Asn AGT-AAC	GGCCGTACCTCTTGGATATAATCGTCCCACACCAGGAGCATGTGT TGCCTATGATCCCTA <u>A</u> CGGTGGGGCTTTCAAGGATATGATCCTGG ATGGTGATGGCAGGACTGTGTACTGATCTAA	4425
	TTAGATCAGTACACAGTCCTGCCATCACCATCCAGGATCATATCCT TGAAAGCCCCACC <u>G</u> TAGGGATCATAGGCAACACATGCTCCTGGT GTGGGACGATTATATCCAAGAGGTACGGCC	4426
	GATCCCTA <u>A</u> CGGTGGGG	4427
	CCCCACC <u>G</u> TAGGGATC	4428
25 Sulfonylurea Resistance ALS <i>Lolium multiflorum</i> Pro167Ser CCG-TCG	TCCGCGCTCGCCGACGCCCTCCTCGACTCCATCCCCATGGTGGC CATCACGGGGGAGGTG <u>T</u> CGCGCCGCATGATCGGCACGGACGCC TTCCAGGAGACGCCCATCGTCGAGGTCACCCGCT	4429
	AGCGGGTGACCTCGACGATGGGCGTCTCCTGGAAGGCGTCCGT GCCGATCATGCGGCGCGA <u>A</u> GACCTGCCCGTGATGGCCACCATG GGGATGGAGTCGAGGAGGGCGTCGGCGAGCGCGGA	4430

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GGCAGGTC <u>I</u> CGCGCCGC	4431
	GCGGCGCG <u>A</u> GACCTGCC	4432
5 Sulfonylurea Resistance ALS <i>Lolium multiflorum</i> Pro167Gln CCG-CAG	CCGCGCTCGCCGACGCCCTCCTCGACTCCATCCCCATGGTGGCC ATCACGGGGCAGGTCC <u>A</u> GCGCCGCATGATCGGCACGGACGCCT TCCAGGAGACGCCCATCGTCGAGGTCACCCGCTC	4433
	GAGCGGGTGACCTCGACGATGGGCGTCTCCTGGAAGGCGTCCG TGCCGATCATGCGGCGC <u>T</u> GGACCTGCCCCGTGATGGCCACCATG GGGATGGAGTCGAGGAGGGCGTCGGCGAGCGCGG	4434
	GCAGGTCC <u>A</u> GCGCCGCA	4435
	TGCGGCGC <u>T</u> GGACCTGC	4436
10 Imidazolinone Resistance ALS <i>Lolium multiflorum</i> Ser623Asn AGC-AAC	CTGGGCCATACTTGTTGGATATCATCGTCCCTCACCAGGAGCATG TGCTGCCTATGATCCCTA <u>A</u> CGGTGGTGCTTTCAAGGACATTATCA TGGAAGGTGATGGCAGGATTCGTATTAAC	4437
	GTTTAATACGAAATCCTGCCATCACCTTCCATGATAATGTCCTTGA AAGCACCACCG <u>T</u> TAGGGATCATAGGCAGCACATGCTCCTGGTGA GGGACGATGATATCCAACAAGTATGGCCCAG	4438
	GATCCCTA <u>A</u> CGGTGGTG	4439
	CACCACCG <u>T</u> TAGGGATC	4440
15 Sulfonylurea Resistance ALS <i>Hordeum vulgare</i> Pro68Ser CCA-TCA	TCCGCGCTCGCCGACGCTCTCCTCGACTCCATCCCCATGGTCGC CATCACGGGCCAGGTCT <u>C</u> ACGCCGCATGATCGGCACGGACGCGT TCCAGGAGACGCCCATAGTGGAGGTCACGCGCT	4441
	AGCGCGTGACCTCCACTATGGGCGTCTCCTGGAACGCGTCCGTG CCGATCATGCGGCGTG <u>A</u> GACCTGGCCCGTGATGGCGACCATGG GGATGGAGTCGAGGAGAGCGTCGGCGAGCGCGGA	4442
	GCCAGGTCTCAGCCGC	4443
	GCGGCGTG <u>A</u> GACCTGGC	4444
20 Sulfonylurea Resistance ALS <i>Hordeum vulgare</i> Pro68Gln CCA-CAA	CCGCGCTCGCCGACGCTCTCCTCGACTCCATCCCCATGGTCGCC ATCACGGGCCAGGTCC <u>A</u> ACGCCGCATGATCGGCACGGACGCGTT CCAGGAGACGCCCATAGTGGAGGTCACGCGCTC	4445
	GAGCGCGTGACCTCCACTATGGGCGTCTCCTGGAACGCGTCCGT GCCGATCATGCGGCGT <u>T</u> GGACCTGGCCCGTGATGGCGACCATGG GGATGGAGTCGAGGAGAGCGTCGGCGAGCGCGG	4446
	CCAGGTCC <u>A</u> ACGCCGCA	4447
	TGCGGCGT <u>T</u> GGACCTGG	4448

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Imidazolinone Resistance ALS <i>Hordeum vulgare</i> Ser524Asn AGC-AAC	CCCAGGGCCGTACCTGCTGGATATCATTGTCCCGCATCAGGAGC ACGTGCTGCCTATGATCCCAA <u>A</u> CGGTGGTGCTTTCAAGGACATGA TCATGGAGGGTGATGGCAGGACCTCGTACTGA	4449
	TCAGTACGAGGTCTGCCATCACCTCCATGATCATGTCCTTGAA AGCACCACCGT <u>TT</u> GGGATCATAGGCAGCACGTGCTCCTGATGCG GGACAATGATATCCAGCAGGTACGGCCCTGGG	4450
	GATCCCAA <u>A</u> CGGTGGTG	4451
	CACCACCGT <u>TT</u> GGGATC	4452
10 Sulfonylurea Resistance ALS <i>Gossypium hirsutum</i> Pro186Ser CCT-TCT	AGTGGTCTCGCTGATGCAATGCTCGATAGTATCCCTCTCGTGGCG ATCACTGGTCAAGTC <u>T</u> CTCGTCGGATGATCGGTACCGATGCTTTC CAGGAACTCCAATTGTTGAGGTAACAAGGT	4453
	ACCTTGTTACCTCAACAATTGGAGTTTCCTGGAAAGCATCGGTAC CGATCATCCGACGAGAGACTTGACCAGTGATCGCCACGAGAGGG ATACTATCGAGCATTGCATCAGCGAGACCACT	4454
	GTCAAGTC <u>T</u> CTCGTCGG	4455
	CCGACGAGAGACTTGAC	4456
15 Sulfonylurea Resistance ALS <i>Gossypium hirsutum</i> Pro186Gln CCT-CAA	GTGGTCTCGCTGATGCAATGCTCGATAGTATCCCTCTCGTGGCGA TCACTGGTCAAGTCC <u>A</u> ACGTCCGATGATCGGTACCGATGCTTTC AGGAACTCCAATTGTTGAGGTAACAAGGTC	4457
	GACCTTGTTACCTCAACAATTGGAGTTTCCTGGAAAGCATCGGTA CCGATCATCCGACG <u>TT</u> GGACTTGACCAGTGATCGCCACGAGAGG GATACTATCGAGCATTGCATCAGCGAGACCAC	4458
	TCAAGTCC <u>A</u> ACGTCCGA	4459
	TCCGACG <u>TT</u> GGACTTGA	4460
20 Sulfonylurea Resistance ALS <i>Gossypium hirsutum</i> Pro186Gln CCT-CAG	GTGGTCTCGCTGATGCAATGCTCGATAGTATCCCTCTCGTGGCGA TCACTGGTCAAGTCC <u>A</u> ACGTCCGATGATCGGTACCGATGCTTTC AGGAACTCCAATTGTTGAGGTAACAAGGTC	4461
	GACCTTGTTACCTCAACAATTGGAGTTTCCTGGAAAGCATCGGTA CCGATCATCCGACG <u>CT</u> GGACTTGACCAGTGATCGCCACGAGAGG GATACTATCGAGCATTGCATCAGCGAGACCAC	4462
	TCAAGTCC <u>A</u> ACGTCCGA	4463
	TCCGACG <u>CT</u> GGACTTGA	4464
25 Imidazolinone Resistance ALS <i>Gossypium hirsutum</i> Ser642Asn AGT-AAT	GACCTTACTTGTTGGATGTGATTGTCCACATCAAGAACATGTCCT GCCTATGATCCCCA <u>A</u> TGGAGGCGCTTTCAAAGATGTGATCACAGA GGGTGATGGAAGAACAATATTGACCTCA	4465
	TGAGGTCAATATTGTGTTCTTCCATCACCTCTGTGATCACATCTT TGAAAGCGCCTCCA <u>TT</u> GGGGATCATAGGCAGGACATGTTCTTGAT GTGGGACAAATCACATCCAACAAGTAAGGTC	4466
	GATCCCCA <u>A</u> TGGAGGCG	4467

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CGCCTCCA <u>T</u> TGGGGATC	4468
5 Sulfonylurea Resistance ALS <i>Amaranthus retroflexus</i> Pro192Ser CCC-TCC	TCTGGTCTTGCTGATGCACTTCTTGACTCAGTCCCTCTTGTCGCC ATTACTGGGCAAGTTCCCGGCGTATGATTGGTACTGATGCTTTTC AAGAGACTCCAATTGTTGAGGTAACTCGAT	4469
	ATCGAGTTACCTCAACAATTGGAGTCTCTTGAAAAGCATCAGTACC AATCATACGCCGGGA <u>A</u> ACTTGCCAGTAATGGCGACAAGAGGGA CTGAGTCAAGAAGTGCATCAGCAAGACCAGA	4470
	GGCAAGTTCCCGGCGT	4471
	ACGCCGGGA <u>A</u> ACTTGCC	4472
10 Sulfonylurea Resistance ALS <i>Amaranthus retroflexus</i> Pro192Gln CCC-CAA	CTGGTCTTGCTGATGCACTTCTTGACTCAGTCCCTCTTGTCGCCA TTACTGGGCAAGTTCAACGGCGTATGATTGGTACTGATGCTTTTC AAGAGACTCCAATTGTTGAGGTAACTCGATC	4473
	GATCGAGTTACCTCAACAATTGGAGTCTCTTGAAAAGCATCAGTAC CAATCATACGCCGTTGA <u>A</u> CTTGCCAGTAATGGCGACAAGAGGGA CTGAGTCAAGAAGTGCATCAGCAAGACCAG	4474
	GCAAGTTCAACGGCGTA	4475
	TACGCCGTTGA <u>A</u> CTTGC	4476
15 Sulfonylurea Resistance ALS <i>Amaranthus retroflexus</i> Pro192Gln CCC-CAG	CTGGTCTTGCTGATGCACTTCTTGACTCAGTCCCTCTTGTCGCCA TTACTGGGCAAGTTCAAGCGGCGTATGATTGGTACTGATGCTTTTC AAGAGACTCCAATTGTTGAGGTAACTCGATC	4477
	GATCGAGTTACCTCAACAATTGGAGTCTCTTGAAAAGCATCAGTAC CAATCATACGCCGCTGA <u>A</u> CTTGCCAGTAATGGCGACAAGAGGG ACTGAGTCAAGAAGTGCATCAGCAAGACCAG	4478
	GCAAGTTCAAGCGGCGTA	4479
	TACGCCGCTGA <u>A</u> CTTGC	4480
25 Imidazolinone Resistance ALS <i>Amaranthus retroflexus</i> Ser652Asn AGC-AAC	GACCGTATCTGCTGGATGTAATCGTACCACATCAGGAGCATGTGC TGCCTATGATCCCTAACGGTGCCGCCTTCAAGGACACCATAACAG AGGGTGATGGAAGAAGGGCTTATTAGTTGGT	4481
	ACCAACTAATAAGCCCTTCTTCCATCACCCTCTGTTATGGTGTCTT TGAAGGCGGCACCGTTAGGGATCATAGGCAGCACATGCTCCTGA TGTGGTACGATTACATCCAGCAGATACGGTC	4482
	GATCCCTAACGGTGCCG	4483
	CGGCACCGTTAGGGATC	4484

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Sulfonylurea Resistance ALS 1 <i>Nicotiana tabacum</i> Pro194Ser CCA-TCA	AGCGGCCTCGCTGACGCGCTACTGGATAGCGTCCCCATTGTTGC TATAACAGGTCAAGTGTCACGTAGGATGATAGGTACTGATGCTTTT CAGGAAACTCCTATTGTTGAGGTAAGTAGAT	4485
	ATCTAGTTACCTCAACAATAGGAGTTTCCTGAAAAGCATCAGTACC TATCATCCTACGTGACACTTGACCTGTTATAGCAACAATGGGGAC GCTATCCAGTAGCGCGTCAGCGAGGCCGCT	4486
	GTCAAGTGTCACGTAGG	4487
	CCTACGTGACACTTGAC	4488
10 Sulfonylurea Resistance ALS 1 <i>Nicotiana tabacum</i> Pro194Gln CCA-CAA	GCGGCCTCGCTGACGCGCTACTGGATAGCGTCCCCATTGTTGCT ATAACAGGTCAAGTGCAACGTAGGATGATAGGTACTGATGCTTTT CAGGAAACTCCTATTGTTGAGGTAAGTAGATC	4489
	GATCTAGTTACCTCAACAATAGGAGTTTCCTGAAAAGCATCAGTAC CTATCATCCTACGTGACACTTGACCTGTTATAGCAACAATGGGGA CGCTATCCAGTAGCGCGTCAGCGAGGCCGC	4490
	TCAAGTGCAACGTAGGA	4491
	TCCTACGTGACACTTGA	4492
15 Imidazolinone Resistance ALS 1 <i>Nicotiana tabacum</i> Ser650Asn AGT-AAT	GGCCATACTTGTGGATGTGATTGTACCTCATCAGGAACATGTTTT ACCTATGATTCCCAATGGCGGAGCTTTCAAAGATGTGATCACAGA GGGTGACGGGAGAAAGTTCTATTGAGTTTG	4493
	CAAACCTCAATAGGAACTTCTCCCGTCACCCTCTGTGATCACATCTT TGAAAGCTCCGCCATTGGGAATCATAGGTAAACATGTTCTCTGAT GAGGTACAATCACATCCAACAAGTATGGCC	4494
	GATTCCCAATGGCGGAG	4495
	CTCCGCCATTGGGAATC	4496
20 Sulfonylurea Resistance ALS 2 <i>Nicotiana tabacum</i> Pro191Ser CCA-TCA	AGTGGCCTCGCGGACGCCCTACTGGATAGCGTCCCCATTGTTGC TATAACCGGTCAAGTGTCACGTAGGATGATCGGTACTGATGCTTTT CAGGAAACTCCGATTGTTGAGGTAAGTAGAT	4497
	ATCTAGTTACCTCAACAATCGGAGTTTCCTGAAAAGCATCAGTACC GATCATCCTACGTGACACTTGACCGGTTATAGCAACAATGGGGAC GCTATCCAGTAGGGCGTCCGCGAGGCCACT	4498
	GTCAAGTGTCACGTAGG	4499
	CCTACGTGACACTTGAC	4500
25 Sulfonylurea Resistance ALS 2 <i>Nicotiana tabacum</i> Pro191Gln CCA-CAA	GTGGCCTCGCGGACGCCCTACTGGATAGCGTCCCCATTGTTGCT ATAACCGGTCAAGTGCAACGTAGGATGATCGGTACTGATGCTTTT CAGGAAACTCCGATTGTTGAGGTAAGTAGATC	4501
	GATCTAGTTACCTCAACAATCGGAGTTTCCTGAAAAGCATCAGTAC CGATCATCCTACGTGACACTTGACCGGTTATAGCAACAATGGGGA CGCTATCCAGTAGGGCGTCCGCGAGGCCAC	4502
	TCAAGTGCAACGTAGGA	4503

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TCCTACGT <u>I</u> GCACTTGA	4504
5 Imidazolinone Resistance ALS 2 <i>Nicotiana tabacum</i> Ser647Asn AGT-AAT	GGCCATACTTGTGGATGTGATTGTACCTCATCAGGAACATGTTCT ACCTATGATTCCCA <u>A</u> TGGCGGGGCTTTCAAAGATGTGATCACAGA GGGTGACGGGAGAAGTTCCTATTGACTTTG	4505
	CAAAGTCAATAGGAACCTCTCCCGTCACCCTCTGTGATCACATCTT TGAAAGCCCCGCCA <u>T</u> TGGGAATCATAGGTAGAACATGTTCTCTGAT GAGGTACAATCACATCCAACAAGTATGGCC	4506
	GATTCCCA <u>A</u> TGGCGGGG	4507
	CCCCGCCA <u>T</u> TGGGAATC	4508
10 Sulfonylurea Resistance ALS <i>Xanthium</i> spp. Pro175Ser CCC-TCC	AGTGGTCTTGCTGATGCTTTATTAGACAGTGTTCCAATGGTTGCTA TACTGGTCAAGTT <u>I</u> CCAGGAGAATGATTGGAACAGATGCGTTTCA AGAAACCCCTATTGTTGAGGTAACACGTT	4509
	AACGTGTTACCTCAACAATAGGGGTTTCTTGAAACGCATCTGTTCC AATCATTCTCCTGGA <u>A</u> ACTTGACCAGTAATAGCAACCATTGGAACA CTGTCTAATAAAGCATCAGCAAGACCACT	4510
	GTCAAGTT <u>I</u> CCAGGAGA	4511
	TCTCCTGG <u>A</u> AACTTGAC	4512
15 Sulfonylurea Resistance ALS <i>Xanthium</i> spp. Pro175Gln CCC-CAA	GTGGTCTTGCTGATGCTTTATTAGACAGTGTTCCAATGGTTGCTAT TACTGGTCAAGTTCA <u>A</u> AGGAGAATGATTGGAACAGATGCGTTTCA AGAAACCCCTATTGTTGAGGTAACACGTT	4513
	GAACGTGTTACCTCAACAATAGGGGTTTCTTGAAACGCATCTGTTCC CAATCATTCTCCT <u>I</u> TGAACCTTGACCAGTAATAGCAACCATTGGAAC ACTGTCTAATAAAGCATCAGCAAGACCAC	4514
	TCAAGTTC <u>A</u> AAGGAGAA	4515
	TTCTCCT <u>I</u> TGAACCTTGA	4516
20 Sulfonylurea Resistance ALS <i>Xanthium</i> spp. Pro175Gln CCC-CAG	GTGGTCTTGCTGATGCTTTATTAGACAGTGTTCCAATGGTTGCTAT TACTGGTCAAGTTCA <u>G</u> AGGAGAATGATTGGAACAGATGCGTTTCA AGAAACCCCTATTGTTGAGGTAACACGTT	4517
	GAACGTGTTACCTCAACAATAGGGGTTTCTTGAAACGCATCTGTTCC CAATCATTCTCCT <u>C</u> TGAACCTTGACCAGTAATAGCAACCATTGGAAC ACTGTCTAATAAAGCATCAGCAAGACCAC	4518
	TCAAGTTC <u>A</u> GAGGAGAA	4519
	TTCTCCT <u>C</u> TGAACCTTGA	4520
25 Imidazolinone Resistance ALS <i>Xanthium</i> spp. Ala631Asn GCT-AAT	GGGCCTTACTTGTGGATGTGATCGTGCCCATCAAGAACATGTG TTGCCCATGATCCCGA <u>A</u> TGGTGGAGGTTTCATGGATGTGATCACC GAAGGCGACGGCAGAATGAAATATTGAGCTT	4521
	AAGCTCAATATTTCACTTCTGCCGTGCGCTTCGGTGATCACATCCAT GAAACCTCCACCA <u>T</u> TCGGGATCATGGGCAACACATGTTCTTGATG GGGCACGATCACATCCAACAAGTAAGGCC	4522

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGATCCCGA <u>A</u> TGGTGGGA	4523
	TCCACCA <u>T</u> TCGGGATCA	4524
Sulfonylurea Resistance ALS <i>Bassia scoparia</i> Pro189Ser CCG-TCG	TCCGGGTTTGCTGATGCTTTGCTCGATTCCGTTCCACTGGTGGCG ATCACGGGGCAGGTG <u>T</u> CGCGGCGAATGATTGGGACGGATGCTTT TCAGGAGACTCCTATTGTTGAGGTAACACGGT	4525
	ACCGTGTTACCTCAACAATAGGAGTCTCCTGAAAAGCATCCGTCC CAATCATTGCGCGCGA <u>C</u> ACCTGCCCCGTGATCGCCACCAGTGGA ACGGAATCGAGCAAAGCATCAGCAAACCCGGA	4526
	GGCAGGTG <u>T</u> CGCGGCGA	4527
	TCGCCGCGA <u>C</u> ACCTGCC	4528
Sulfonylurea Resistance ALS <i>Bassia scoparia</i> Pro189Gln CCG-CAG	CCGGGTTTGCTGATGCTTTGCTCGATTCCGTTCCACTGGTGGCGA TCACGGGGCAGGTGC <u>A</u> GCGGCGAATGATTGGGACGGATGCTTTT CAGGAGACTCCTATTGTTGAGGTAACACGGTC	4529
	GACCGTGTTACCTCAACAATAGGAGTCTCCTGAAAAGCATCCGTC CCAATCATTGCGCGCT <u>G</u> CACCTGCCCCGTGATCGCCACCAGTGG AACGGAATCGAGCAAAGCATCAGCAAACCCGG	4530
	GCAGGTGC <u>A</u> GCGGCGAA	4531
	TTCGCCGCT <u>G</u> CACCTGC	4532
Imidazolinone Resistance ALS <i>Bassia scoparia</i> Ser649Asn AGT-AAT	GACCTTACCTGCTTGATGTGATTGTACCTCATCAGGAGCATGTGC TGCCTATGATTCTTA <u>A</u> TGGTGCAGCCTTCAAGGATATCATTAAACGA AGGTGATGGAAGAACAAGTTATTGATGTTT	4533
	GAACATCAATAACTTGTCTTCCATCACCTTCGTTAATGATATCCTT GAAGGCTGCACCA <u>T</u> AGGAATCATAGGCAGCACATGCTCCTGATG AGGTACAATCACATCAAGCAGGTAAGGTC	4534
	GATTCCTA <u>A</u> TGGTGCAG	4535
	CTGCACCA <u>T</u> AGGAATC	4536
Sulfonylurea Resistance ALS 1 <i>Brassica napus</i> Pro182Ser CCT-TCT	AGCGGGTTAGCAGACGCGATGCTTGACAGTGTTCTCTTGTCGC CATTACAGGACAGGTCTCTCGCCGGATGATCGGTACTGACGCCTT CCAAGAGACACCAATCGTTGAGGTAACGAGGT	4537
	ACCTCGTTACCTCAACGATTGGTGTCTCTTGGAAGGCGTCAGTAC CGATCATCCGGCGAGA <u>G</u> ACCTGTCCTGTAATGGCGACAAGAGGA ACACTGTCAAGCATCGCGTCTGCTAACCCGCT	4538
	GACAGGTCT <u>T</u> CTCGCCGG	4539
	CCGGCGAGA <u>G</u> ACCTGTC	4540

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Sulfonylurea Resistance ALS 1 <i>Brassica napus</i> Pro182Gln CCT-CAA	GCGGGTTAGCAGACGCGATGCTTGACAGTGTTCTCTTGTGCGCC ATTACAGGACAGGTCCA <u>AC</u> GCCGGATGATCGGTACTGACGCCTT CCAAGAGACACCAATCGTTGAGGTAACGAGGTC	4541
	GACCTCGTTACCTCAACGATTGGTGTCTCTTGGAAGGCGTCAGTA CCGATCATCCGGCGT <u>TT</u> GGACCTGTCCTGTAATGGCGACAAGAGG AACACTGTCAAGCATCGCGTCTGCTAACCCTGC	4542
	ACAGGTCCA <u>AC</u> GCCCGGA	4543
	TCCGGCGT <u>TT</u> GGACCTGT	4544
10 Sulfonylurea Resistance ALS 1 <i>Brassica napus</i> Pro182Gln CCT-CAG	GCGGGTTAGCAGACGCGATGCTTGACAGTGTTCTCTTGTGCGCC ATTACAGGACAGGTCCA <u>AG</u> GCCGGATGATCGGTACTGACGCCTT CCAAGAGACACCAATCGTTGAGGTAACGAGGTC	4545
	GACCTCGTTACCTCAACGATTGGTGTCTCTTGGAAGGCGTCAGTA CCGATCATCCGGCGC <u>T</u> GGACCTGTCCTGTAATGGCGACAAGAGG AACACTGTCAAGCATCGCGTCTGCTAACCCTGC	4546
	ACAGGTCCA <u>AG</u> GCCCGGA	4547
	TCCGGCGC <u>T</u> GGACCTGT	4548
15 Imidazolinone Resistance ALS 1 <i>Brassica napus</i> Ser638Asn AGT-AAT	GACCATACCTGTTGGATGTGATATGTCCGCACCAAGAACATGTGT TACCGATGATCCCAA <u>AT</u> TGGTGGCACTTTCAAAGATGTAATAACAGA AGGGGATGGTCGCACTAAGTACTGAGAGAT	4549
	ATCTCTCAGTACTTAGTGCGACCATCCCCTTCTGTTATTACATCTT TGAAAGTGCCACCA <u>TT</u> TGGGATCATCGGTAACACATGTTCTTGGT GCGGACATATCACATCCAACAGGTATGGTC	4550
	GATCCCAA <u>AT</u> TGGTGGCA	4551
	TGCCACCA <u>TT</u> TGGGATC	4552
20 Sulfonylurea Resistance ALS 2 <i>Brassica napus</i> Pro126Ser CCC-TCC	CAGCGGGTTAGCAGACGCGATGCTTGACAGTGTTCTCTTGTGCG CCATTACAGGACAGGT <u>TC</u> CTCGCCGGATGATCGGTACTGACGCC TTCCAAGAGACACCAATCGTTGAGGTAACGAGG	4553
	CCTCGTTACCTCAACGATTGGTGTCTCTTGGAAGGCGTCAGTACC GATCATCCGGCGAGGA <u>AC</u> CTGTCCTGTAATGGCGACAAGAGGAA CACTGTCAAGCATCGCGTCTGCTAACCCTGCTG	4554
	GGACAGGT <u>TC</u> CTCGCCG	4555
	CGGCGAGGA <u>AC</u> CTGTCC	4556
25 Sulfonylurea Resistance ALS 2 <i>Brassica napus</i> Pro126Gln CCC-CAG	AGCGGGTTAGCAGACGCGATGCTTGACAGTGTTCTCTTGTGCGC CATTACAGGACAGGTCA <u>CT</u> CGCCGGATGATCGGTACTGACGCCT TCCAAGAGACACCAATCGTTGAGGTAACGAGGT	4557
	ACCTCGTTACCTCAACGATTGGTGTCTCTTGGAAGGCGTCAGTAC CGATCATCCGGCGAGT <u>G</u> ACCTGTCCTGTAATGGCGACAAGAGGA ACACTGTCAAGCATCGCGTCTGCTAACCCTGCT	4558
	GACAGGTCA <u>CT</u> CGCCGG	4559

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CCGGCGAGT <u>G</u> ACCTGTC	4560
Imidazolinone Resistance ALS 2 <i>Brassica napus</i> Ser582Asn AGT-AAT	GACCATACCTGTTGGATGTGATATGTCCGCACCAAGAACATGTGT TACCGATGATCCCAA <u>A</u> TGGTGGCACTTTCAAAGATGTAATAACAGA AGGGGATGGTCGCACTAAGTACTGAGAGAT	4561
	ATCTCTCAGTACTTAGTGCGACCATCCCCTTCTGTTATTACATCTT TGAAAGTGCCACCA <u>T</u> TTGGGATCATCGGTAACACATGTTCTTGGT GCGGACATATCACATCCAACAGGTATGGTC	4562
	GATCCCAA <u>A</u> TGGTGGCA	4563
	TGCCACCA <u>T</u> TTGGGATC	4564
Sulfonylurea Resistance ALS 3 <i>Brassica napus</i> Pro179Ser CCT-TCT	AGCGGGTTAGCCGACGCGATGCTTGACAGTGTTCTCTCGTCGC CATCACAGGACAGGT <u>C</u> TCTCGCCGGATGATCGGTAAGTACTGACGCGT TCCAAGAGACGCCAATCGTTGAGGTAACGAGGT	4565
	ACCTCGTTACCTCAACGATTGGCGTCTCTTGGAACGCGTCAGTAC CGATCATCCGGCGAG <u>A</u> GACCTGTCCTGTGATGGCGACGAGAGGA AACTGTCAAGCATCGCGTCGGCTAACCCGCT	4566
	GACAGGT <u>C</u> TCTCGCCGG	4567
	CCGGCGAG <u>A</u> GACCTGTC	4568
Sulfonylurea Resistance ALS 3 <i>Brassica napus</i> Pro179Gln CCT-CAA	GCGGGTTAGCCGACGCGATGCTTGACAGTGTTCTCTCGTCGCC ATCACAGGACAGGTCC <u>A</u> ACGCCGGATGATCGGTAAGTACTGACGCGTT CCAAGAGACGCCAATCGTTGAGGTAACGAGGTC	4569
	GACCTCGTTACCTCAACGATTGGCGTCTCTTGGAACGCGTCAGTA CCGATCATCCGGCG <u>T</u> TGGACCTGTCCTGTGATGGCGACGAGAGG AACTGTCAAGCATCGCGTCGGCTAACCCGC	4570
	ACAGGTCC <u>A</u> ACGCCGGA	4571
	TCCGGCG <u>T</u> TGGACCTGT	4572
Sulfonylurea Resistance ALS 3 <i>Brassica napus</i> Pro179Gln CCT-CAG	GCGGGTTAGCCGACGCGATGCTTGACAGTGTTCTCTCGTCGCC ATCACAGGACAGGTCC <u>A</u> CGGCCGGATGATCGGTAAGTACTGACGCGTT CCAAGAGACGCCAATCGTTGAGGTAACGAGGTC	4573
	GACCTCGTTACCTCAACGATTGGCGTCTCTTGGAACGCGTCAGTA CCGATCATCCGGCG <u>C</u> TGGACCTGTCCTGTGATGGCGACGAGAGG AACTGTCAAGCATCGCGTCGGCTAACCCGC	4574
	ACAGGTCC <u>A</u> CGGCCGGA	4575
	TCCGGCG <u>C</u> TGGACCTGT	4576
Imidazolinone Resistance ALS 3 <i>Brassica napus</i> Ser635Asn AGT-AAT	GACCGTACCTGTTGGATGTCATCTGTCCGCACCAAGAACATGTGT TACCGATGATCCCAA <u>A</u> TGGTGGCACTTTCAAAGATGTAATAACCG AAGGGGATGGTCGCACTAAGTACTGAGAGAT	4577
	ATCTCTCAGTACTTAGTGCGACCATCCCCTTCGGTTATTACATCTT TGAAAGTGCCACCA <u>T</u> TTGGGATCATCGGTAACACATGTTCTTGGT GCGGACAGATGACATCCAACAGGTACGGTC	4578

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	GATCCCAA <u>A</u> TGGTGGCA	4579
	TGCCACCA <u>T</u> TTGGGATC	4580
	TCCGCGCTCGCCGACGCGCTGCTCGACTCCGTCCCGATGGTCCG CCATCACGGGGCCAGGTCTCCCGCCGCATGATCGGCACCGACGC CTTCCAGGAGACGCCCATAGTCGAGGTCACCCGCT	4581
	AGCGGGTGACCTCGACTATGGGCGTCTCCTGGAAGGCGTCGGTG CCGATCATGCGGGCGGGAGACCTGGCCCGTGATGGCGACCATCG GGACGGAGTCGAGCAGCGCGTCGGCGAGCGCGGA	4582
	GCCAGGTCTCCCGCCGC	4583
10	GCGGCGGGAGACCTGGC	4584
	CCGCGCTCGCCGACGCGCTGCTCGACTCCGTCCCGATGGTCCG CATCACGGGGCCAGGTCCAACGCCGCATGATCGGCACCGACGCC TTCCAGGAGACGCCCATAGTCGAGGTCACCCGCTC	4585
	GAGCGGGTGACCTCGACTATGGGCGTCTCCTGGAAGGCGTCGGT GCCGATCATGCGGCGTTGGACCTGGCCCGTGATGGCGACCATCG GGACGGAGTCGAGCAGCGCGTCGGCGAGCGCGG	4586
	CCAGGTCCAACGCCGCA	4587
	TGCGGCGTTGGACCTGG	4588
15	CCGCGCTCGCCGACGCGCTGCTCGACTCCGTCCCGATGGTCCG CATCACGGGGCCAGGTCCAAGCGCCGCATGATCGGCACCGACGCC TTCCAGGAGACGCCCATAGTCGAGGTCACCCGCTC	4589
	GAGCGGGTGACCTCGACTATGGGCGTCTCCTGGAAGGCGTCGGT GCCGATCATGCGGCGTTGGACCTGGCCCGTGATGGCGACCATC GGGACGGAGTCGAGCAGCGCGTCGGCGAGCGCGG	4590
	CCAGGTCCAAGCGCCGCA	4591
	TGCGGCGCTGGACCTGG	4592
	GGCCATACTTGTTGGATATCATCGTCCCGCACCAGGAGCATGTGC TGCTATGATCCCAAATGGGGGCGCATTCAAGGACATGATCCTGG ATGGTGATGGCAGGACTGTGTATTAATCTAT	4593
20	ATAGATTAATACACAGTCCTGCCATCACCATCCAGGATCATGTCCT TGAATGCGCCCCCATTTGGGATCATAGGCAGCACATGCTCCTGGT GCGGGACGATGATATCCAACAAGTATGGCC	4594
	GATCCCAAATGGGGGCG	4595
	CGCCCCCATTTGGGATC	4596

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Sulfonylurea Resistance ALS <i>Zea mays</i> Pro165Ser CCG-TCG	TCTGCGCTCGCAGACGCGTTGCTCGACTCCGTCCCCATGGTCGC CATCACGGGACAGGTGTCGCGACGCATGATTGGCACCGACGCCT TTCAGGAGACGCCCATCGTCGAGGTCACCCGCT	4597
	AGCGGGTGACCTCGACGATGGGCGTCTCCTGAAAGGCGTCGGTG CCAATCATGCGTCGCGACACCTGTCCCGTGATGGCGACCATGGG GACGGAGTCGAGCAACGCGTCTGCGAGCGCAGA	4598
	GACAGGTGTCGCGACGC	4599
	GCGTCGCGACACCTGTC	4600
10 Sulfonylurea Resistance ALS <i>Zea mays</i> Pro165Gln CCG-CAG	CTGCGCTCGCAGACGCGTTGCTCGACTCCGTCCCCATGGTCGCC ATCACGGGACAGGTGCAGCGACGCATGATTGGCACCGACGCCTT TCAGGAGACGCCCATCGTCGAGGTCACCCGCTC	4601
	GAGCGGGTGACCTCGACGATGGGCGTCTCCTGAAAGGCGTCGGT GCCAATCATGCGTCGCTGCACCTGTCCCGTGATGGCGACCATGG GGACGGAGTCGAGCAACGCGTCTGCGAGCGCAG	4602
	ACAGGTGCAGCGACGCA	4603
	TGCGTCGCTGCACCTGT	4604
15 Imidazolinone Resistance ALS <i>Zea mays</i> Ser621Asn AGT-AAT	GGCCGTACCTCTTGGATATAATCGTCCCGCACCAGGAGCATGTGT TGCCTATGATCCCTAATGGTGGGGCTTTCAAGGATATGATCCTGG ATGGTGATGGCAGGACTGTGTATTGATCCGT	4605
	ACGGATCAATACACAGTCCTGCCATCACCATCCAGGATCATATCC TTGAAAGCCCCACCAATTAGGGATCATAGGCAACACATGCTCCTGG TGCGGGACGATTATATCCAAGAGGTACGGCC	4606
	GATCCCTAATGGTGGGG	4607
	CCCCACCAATTAGGGATC	4608
20 Sulfonylurea Resistance ALS <i>Gossypium hirsutum</i> Pro186Ser CCT-TCT	AGTGGTCTCGCTGATGCAATGCTCGATAGTATCCCTCTCGTGGCG ATCACTGGTCAAGTCTCTCGTCGGATGATCGGTACCGATGCTTTCC CAGGAACTCCAATTGTTGAGGTAACAAGGT	4609
	ACCTTGTTACCTCAACAATTGGAGTTTCCTGGAAAGCATCGGTAC CGATCATCCGACGAGAGACTTGACCAGTGATCGCCACGAGAGGG ATACTATCGAGCATTGCATCAGCGAGACCACT	4610
	GTCAAGTCTCTCGTCGG	4611
	CCGACGAGAGACTTGAC	4612
25 Sulfonylurea Resistance ALS <i>Gossypium hirsutum</i> Pro186Gln CCT-CAA	GTGGTCTCGCTGATGCAATGCTCGATAGTATCCCTCTCGTGGCGA TCACTGGTCAAGTCCAACGTCGGATGATCGGTACCGATGCTTTCC AGGAACTCCAATTGTTGAGGTAACAAGGTC	4613
	GACCTTGTTACCTCAACAATTGGAGTTTCCTGGAAAGCATCGGTA CCGATCATCCGACGTTGGACTTGACCAGTGATCGCCACGAGAGG GATACTATCGAGCATTGCATCAGCGAGACCAC	4614
	TCAAGTCCAACGTCGGA	4615

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TCCGACG <u>TT</u> GGACTTGA	4616
5 Sulfonylurea Resistance ALS <i>Gossypium hirsutum</i> Pro186Gln CCT-CAG	GTGGTCTCGCTGATGCAATGCTCGATAGTATCCCTCTCGTGCGCA TCACTGGTCAAGTCCAGCGTCGGATGATCGGTACCGATGCTTTCC AGGAACTCCAATTGTTGAGGTAACAAGGTC	4617
	GACCTTGTTACCTCAACAATTGGAGTTTCTTGAAAGCATCGGTA CCGATCATCCGACGCTGGACTTGACCAGTGATCGCCACGAGAGG GATACTATCGAGCATTGCATCAGCGAGACCAC	4618
	TCAAGTCCAGCGTCGGA	4619
	TCCGACGCTGGACTTGA	4620
10 Imidazolinone Resistance ALS <i>Gossypium hirsutum</i> Ser642Asn AGT-AAT	GACCTTACTTGTTGGATGTGATTGTCCACATCAAGAACATGTCCT GCCTATGATCCCCAATGGAGGGGCTTTCAAAGATGTGATCACAGA GGGTGATGGAAGAACAATATTGACCTCA	4621
	TGAGGTCAATATTGTGTTCTTCCATCACCTCTGTGATCACATCTT TGAAAGCCCCTCCATTGGGGATCATAGGCAGGACATGTTCTTGAT GTGGGACAATCACATCCAACAAGTAAGGTC	4622
	GATCCCCAATGGAGGGG	4623
	CCCCTCCAATGGGGATC	4624
15 Sulfonylurea Resistance ALS <i>Amaranthus powellii</i> Pro192Ser CCC-TCC	TCTGGTCTTGCTGATGCACTTCTTGACTCAGTCCCTCTTGTCGCC ATTACTGGGCAAGTTCCCGGCGTATGATTGGTACTGATGCTTTTC AAGAGACTCCAATTGTTGAGGTAACGAT	4625
	ATCGAGTTACCTCAACAATTGGAGTCTCTTGAAAAGCATCAGTACC AATCATACGCCGGGAAGCTTGCCAGTAATGGCGACAAGAGGGA CTGAGTCAAGAAGTGCATCAGCAAGACCAGA	4626
	GGCAAGTTCCCGGCGT	4627
	ACGCCGGGAAGCTTGCC	4628
20 Sulfonylurea Resistance ALS <i>Amaranthus powellii</i> Pro192Gln CCC-CAA	CTGGTCTTGCTGATGCACTTCTTGACTCAGTCCCTCTTGTCGCCA TTACTGGGCAAGTTCAACGGGCGTATGATTGGTACTGATGCTTTTC AAGAGACTCCAATTGTTGAGGTAACGATC	4629
	GATCGAGTTACCTCAACAATTGGAGTCTCTTGAAAAGCATCAGTAC CAATCATACGCCGTGAAGCTTGCCAGTAATGGCGACAAGAGGGA CTGAGTCAAGAAGTGCATCAGCAAGACCAG	4630
	GCAAGTTCAACGGGCGTA	4631
	TACGCCGTGAAGCTTGCC	4632
25 Sulfonylurea Resistance ALS <i>Amaranthus powellii</i> Pro192Gln CCC-CAG	CTGGTCTTGCTGATGCACTTCTTGACTCAGTCCCTCTTGTCGCCA TTACTGGGCAAGTTCAACGGGCGTATGATTGGTACTGATGCTTTTC AAGAGACTCCAATTGTTGAGGTAACGATC	4633
	GATCGAGTTACCTCAACAATTGGAGTCTCTTGAAAAGCATCAGTAC CAATCATACGCCGTGAAGCTTGCCAGTAATGGCGACAAGAGGG ACTGAGTCAAGAAGTGCATCAGCAAGACCAG	4634

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GCAAGTTCAGCGGCGTA	4635
	TACGCCGCTGAACTTGC	4636
Imidazolinone Resistance ALS <i>Amaranthus powellii</i> Ser652Asn AGC-AAC	GACCGTATCTGCTGGATGTAATCGTACCACATCAGGAGCATGTGC TGCCTATGATCCCTAACGGTGCCGCCTTCAAGGACACCATAACAG AGGGTGATGGAAGAAGGGCTTATTAGTTGGT	4637
	ACCAACTAATAAGCCCTTCTTCCATCACCCCTCTGTTATGGTGTCT TGAAGGCGGCACCGTTAGGGATCATAGGCAGCACATGCTCCTGA TGTGGTACGATTACATCCAGCAGATACGGTC	4638
	GATCCCTAACGGTGCCG	4639
	CGGCACCGTTAGGGATC	4640

Table 12
Genome-Altering Oligos Conferring Porphyrin Herbicide Resistance

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Porphyrin Herbicide Resistant PPO <i>Arabidopsis thaliana</i> Val365Met GTT-ATG	TCTTGCGCCCTCTTTCTGAATCTGCTGCAAATGCACTCTCAAACT ATATTACCCACCAATGGCAGCAGTATCTATCTCGTACCCGAAAGA AGCAATCCGAACAGAATGTTTGATAGATGG	4641
	CCATCTATCAAACATTCTGTTCCGATTGCTTCTTTGGGTACGAGA TAGATACTGCTGCCATTGGTGGGTAATATAGTTTTGAGAGTGCATT TGCAGCAGATTGAGAAAGAGGGCGCAAGA	4642
	CCCACCAATGGCAGCAG	4643
	CTGCTGCCATTGGTGGG	4644
10 Porphyrin Herbicide Resistant PPO <i>Nicotiana tabacum</i> Val376Met GTT-ATG	TATTACGTCTCTTTCCGTTGCCGAGCAGATGCACTTTCAAATTT CTACTATCCCCCAATGGGAGCAGTCACAATTTTATATCCTCAAGAA GCTATTCGTGATGAGCGTCTGGTTGATGG	4645
	CCATCAACCAGACGCTCATCACGAATAGCTTCTTGAGGATATGAA ATTGTGACTGCTCCCATTTGGGGGATAGTAGAAATTTGAAAGTGCA TCTGCTGCGGCAACCGAAAGAGGACGTAATA	4646
	TCCCCCAATGGGAGCAG	4647
	CTGCTCCCATTTGGGGGA	4648
15 Porphyrin Herbicide Resistant PPO <i>Cichorium intybus</i> Val383Met GTT-ATG	TGTTGCGTCCGCTTTTCGTTGGGTGCAGCAGATGCATTGTCAAAT TTTATTATCCTCCGATGGCAGCTGTATCAATTTATATCCAAAAGA CGCAATTCGTGCTGACCGGCTGATTGATGG	4649
	CCATCAATCAGCCGGTCAGCACGAATTGCGTCTTTTGGATATGAA ATTGATACAGCTGCCATTCGGAGGATAATAAAATTTGACAATGCAT CTGCTGCACCCAACGAAAGCGGACGCAACA	4650
	TCCTCCGATGGCAGCTG	4651
	CAGCTGCCATTCGGAGGA	4652
20 Porphyrin Herbicide Resistant PPO <i>Spinacia oleracea</i> Val390Met GTT-ATG	TCCTTCGTCCACTTTTCAAGATGTCGCCGAGAATCTCTTTCAAATT TCATTATCCACCAATGGCAGCTGTGTCACTTTTCTATCCTAAAGAA GCAATTAGATCAGAGTGCTTGATTGACGG	4653
	CCGTCAATCAAGCACTCTGATCTAATTGCTTCTTTAGGATAGGAAA GTGACACAGCTGCCATTGGTGGATAATGAAATTTTGAAGAGATTG TGCGGCGACATCTGAAAGTGGACGAAGGA	4654
	TCCACCAATGGCAGCTG	4655
	CAGCTGCCATTGGTGGG	4656

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Porphyrin Herbicide Resistant PPO <i>Zea mays</i> Val363Met GTT-ATG	TTTTGCGTCCACTTTCAAGCGATGCTGCAGATGCTCTATCAAGATT CTATTATCCACCGATGGCTGCTGTAAGTGTTCGTATCCAAAGGAA GCAATTAGAAAAGAATGCTTAATTGATGG	4657
	CCATCAATTAAGCATTCTTTCTAATTGCTTCCTTTGGATACGAAAC AGTTACAGCAGCCATCGGTGGATAATAGAATCTTGATAGAGCATC TGCAGCATCGCTTGAAAGTGGACGCAAAA	4658
	TCCACCGATGGCTGCTG	4659
	CAGCAGCCATCGGTGGA	4660
10 Porphyrin Herbicide Resistant PPO <i>Oryza sativa</i> Val364Met GTT-ATG	TCTTGCGGCCACTTTCAAGTGATGCAGCAGATGCTCTGTCAATATT CTATTATCCACCAATGGCTGCTGTAAGTGTTCATATCCAAAAGAA GCAATTAGAAAAGAATGCTTAATTGACGG	4661
	CCGTCAATTAAGCATTCTTTCTAATTGCTTCCTTTGGATATGAAAC AGTTACAGCAGCCATTGGTGGATAATAGAATATTGACAGAGCATCT GCTGCATCACTTGAAAGTGGCCGCAAGA	4662
	TCCACCAATGGCTGCTG	4663
	CAGCAGCCATTGGTGGGA	4664
15 Porphyrin Herbicide Resistant PPO <i>Chlamydomonas</i> <i>reinhardtii</i> Val389Met GTG-ATG	CTGGTCAAGGAGCAGGCGCCCGCCGCGCCGAGGCCCTGGGCT CCTTCGACTACCCGCCGATGGGCGCCGTGACGCTGTCGTACCCG CTGAGCGCCGTGCGGGAGGAGCGCAAGGCCTCGG	4665
	CCGAGGCCTTGCGCTCCTCCCGCACGGCGCTCAGCGGGTACGA CAGCGTCACGGCGCCCATCGGCGGGTAGTCGAAGGAGCCCAGG GCCTCGGCGGCGGCGGGCGCCTGCTCCTTGACCAG	4666
	ACCCGCCGATGGGCGCC	4667
	GGCGCCCATCGGCGGGT	4668

Table 13
Genome-Altering Oligos Conferring Triazine Resistance

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
25 Triazine Resistant D1 Protein <i>Arabidopsis thaliana</i> Ser264Thr AGT-ACT	AACTTACAACATTGTAGCTGCTCACGGTATTTTGGCCGATTGAT TTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACATTTCTTCTT AGCGGCTTGGCCGGTAGTAGGTATTTG	4669
	CAAATACCTACTACCGGCCAAGCCGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAAATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATGTTGTAAGTTT	4670

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	ATATGCTA <u>C</u> TTTCAACA	4671
	TGTTGAAAGTAGCATAT	4672
5 Triazine Resistant D1 Protein <i>Nicotiana tabacum</i> Ser264Thr AGT-ACT	AAACTTATAACATCGTAGCCGCTCATGGTTATTTTGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACA <u>A</u> CTCTCGTTCGTTACACTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4673
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAGTGTAAAGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCGGCTACGATGTTATAAGTTT	4674
	ATATGCTA <u>C</u> TTTCAACA	4675
	TGTTGAAAGTAGCATAT	4676
10 Triazine Resistant D1 Protein <i>Populus deltoides</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCCGCTCATGGTTATTTTGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTTAACA <u>A</u> CTCTCGCTCTTTACATTTCTTCT TAGCTGCTTGGCCTGTAGTAGGTATCTG	4677
	CAGATACCTACTACAGGCCAAGCAGCTAAGAAGAAATGTAAAGAG CGAGAGTTGTTAAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCATGAGCGGCTACGATATTATAAGTTT	4678
	ATATGCTA <u>C</u> TTTTAACA	4679
	TGTTAAAAGTAGCATAT	4680
15 Triazine Resistant D1 Protein <i>Petunia x hybrida</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCCGCTCATGGTTATTTTGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACA <u>A</u> CTCTCGTTCGTTACACTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4681
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAGTGTAAAGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCGGCTACGATATTATAAGTTT	4682
	ATATGCTA <u>C</u> TTTCAACA	4683
	TGTTGAAAGTAGCATAT	4684
20 Triazine Resistant D1 Protein <i>Magnolia pyramidata</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCTGCTCATGGTTATTTTGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACA <u>A</u> TTCTCGTTCTTTACATTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4685
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCATGAGCAGCTACGATATTATAAGTTT	4686
	ATATGCTA <u>C</u> TTTCAACA	4687
	TGTTGAAAGTAGCATAT	4688
25 Triazine Resistant D1 Protein <i>Medicago sativa</i> Ser264Thr AGT-ACT	AAACCTATAATATTGTAGCAGCTCATGGTTATTTTGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACA <u>A</u> CTCTCGTTCTTTACATTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4689
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAATGTAAAGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCTGCTACAATATTATAGGTTT	4690
	ATATGCTA <u>C</u> TTTCAACA	4691

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGTTGAAAGTAGCATAT	4692
5 Triazine Resistant D1 Protein <i>Glycine max</i> Ser264Thr AGT-ACT	AAACCTATAATATTGTAGCTGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCAACTTTCAACAATTCTCGTTCTTTACATTTCTTCT TAGCTGCTTGGCCTGTAGTAGGTATTTG	4693
	CAAATACCTACTACAGGCCAAGCAGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTTGCATATTGGAAGATCAATCGGCCAAAAT AACCATGAGCAGCTACAATATTATAGGTTT	4694
	ATATGCAACTTTCAACA	4695
	TGTTGAAAGTTGCATAT	4696
10 Triazine Resistant D1 Protein <i>Brassica napus</i> Gly264Thr GGT-ACT	AAACTTACAACATTGTAGCTGCTCACGGTTATTTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACATTTCTTCT TAGCGGCTTGGCCGGTAGTAGGTATTTG	4697
	CAAATACCTACTACCGGCCAAGCCGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATGTTGTAAGTTT	4698
	ATATGCTACTTTCAACA	4699
	TGTTGAAAGTAGCATAT	4700
15 Triazine Resistant D1 Protein <i>Oryza sativa</i> Ser264Thr AGT-ACT	AAACTTATAATATTGTGGCCGCTCATGGTTATTTTGGCCGATTAAAT CTTCCAATATGCTACTTTTAAACAATTCTCGTTCTTTACACTTCTTCT TGGCTGCTTGGCCTGTAGTAGGGATTTG	4701
	CAAATCCCTACTACAGGCCAAGCAGCCAAGAAGAAGTGTAAAGAA CGAGAGTTGTTAAAAGTAGCATATTGGAAGATTAATCGGCCAAAAT AACCATGAGCGGCCACAATATTATAAGTTT	4702
	ATATGCTACTTTTAAACA	4703
	TGTTAAAAGTAGCATAT	4704
20 Triazine Resistant D1 Protein <i>Zea mays</i> Ser264Thr AGT-ACT	AGACTTATAATATTGTGGCTGCTCACGGTTATTTTGGTCGATTAAAT CTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACACTTCTTCT TGGCTGCTTGGCCTGTAGTAGGGATCTG	4705
	CAGATCCCTACTACAGGCCAAGCAGCCAAGAAGAAGTGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATTAATCGACCAAAT AACCGTGAGCAGCCACAATATTATAAGTCT	4706
	ATATGCTACTTTCAACA	4707
	TGTTGAAAGTAGCATAT	4708
25 Triazine Resistant D1 Protein <i>Arabidopsis thaliana</i> Ser264Thr AGT-ACT	AAACTTACAACATTGTAGCTGCTCACGGTTATTTTGGCCGATTGAT TTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACATTTCTTCT AGCGGCTTGGCCGGTAGTAGGTATTTG	4709
	CAAATACCTACTACCGGCCAAGCCGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATTAATCGGCCAAAAT AACCGTGAGCAGCTACAATGTTGTAAGTTT	4710
	ATATGCTACTTTCAACA	4711
	TGTTGAAAGTAGCATAT	4712

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Triazine Resistant D1 Protein <i>Nicotiana tabacum</i> Ser264Thr AGT-ACT	AAACTTATAACATCGTAGCCGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACAACCTCTCGTTCGTTACACTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4713
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAGTGTAAACGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCGGCTACGATGTTATAAGTTT	4714
	ATATGCTA <u>C</u> TTTCAACA	4715
	TGTTGAAAGTAGCATAT	4716
10 Triazine Resistant D1 Protein <i>Populus deltoides</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCCGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTTAACAACCTCTCGCTCTTACATTCTTCT TAGCTGCTTGGCCTGTAGTAGGTATCTG	4717
	CAGATACCTACTACAGGCCAAGCAGCTAAGAAGAAATGTAAAGAG CGAGAGTTGTTAAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCATGAGCGGCTACGATATTATAAGTTT	4718
	ATATGCTA <u>C</u> TTTTAACA	4719
	TGTTAAAAGTAGCATAT	4720
15 Triazine Resistant D1 Protein <i>Petunia x hybrida</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCCGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACAACCTCTCGTTCGTTACACTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4721
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAGTGTAAACGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCGGCTACGATATTATAAGTTT	4722
	ATATGCTA <u>C</u> TTTCAACA	4723
	TGTTGAAAGTAGCATAT	4724
20 Triazine Resistant D1 Protein <i>Magnolia pyramidata</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCTGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACAATTCTCGTTCCTTACATTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4725
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCATGAGCAGCTACGATATTATAAGTTT	4726
	ATATGCTA <u>C</u> TTTCAACA	4727
	TGTTGAAAGTAGCATAT	4728
25 Triazine Resistant D1 Protein <i>Medicago sativa</i> Ser264Thr AGT-ACT	AAACCTATAATATTGTAGCAGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTA <u>C</u> TTTCAACAACCTCTCGTTCCTTACATTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4729
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAATGTAAAGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCTGCTACAATATTATAGGTTT	4730
	ATATGCTA <u>C</u> TTTCAACA	4731
	TGTTGAAAGTAGCATAT	4732

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO
5 Triazine Resistant D1 Protein <i>Glycine max</i> Ser264Thr AGT-ACT	AAACCTATAATATTGTAGCTGCTCATGGTTATTTGGCCGATTGAT CTTCCAATATGCAACTTTCAACAATTCTCGTTCTTTACATTTCTTCT TAGCTGCTTGGCCTGTAGTAGGTATTTG	4733
	CAAATACCTACTACAGGCCAAGCAGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTTGCATATTGGAAGATCAATCGGCCAAAAT AACCATGAGCAGCTACAATATTATAGGTTT	4734
	ATATGCAACTTTCAACA	4735
	TGTTGAAAGTTGCATAT	4736
10 Triazine Resistant D1 Protein <i>Brassica napus</i> Gly264Thr GGT-ACT	AAACTTACAACATTGTAGCTGCTCACGGTTATTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACATTTCTTCT TAGCGGCTTGGCCGGTAGTAGGTATTTG	4737
	CAAATACCTACTACCGGCCAAGCCGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATGTTGTAAGTTT	4738
	ATATGCTACTTTCAACA	4739
	TGTTGAAAGTAGCATAT	4740
15 Triazine Resistant D1 Protein <i>Oryza sativa</i> Ser264Thr AGT-ACT	AAACTTATAATATTGTGGCCGCTCATGGTTATTTTGGCCGATTAAT CTTCCAATATGCTACTTTTAACAACCTCTCGTTCTTTACACTTCTTCT TGGCTGCTTGGCCTGTAGTAGGGATTTG	4741
	CAAATCCCTACTACAGGCCAAGCAGCCAAGAAGAAGTGTAAAGAA CGAGAGTTGTTAAAAGTAGCATATTGGAAGATTAATCGGCCAAAAT AACCATGAGCGGCCACAATATTATAAGTTT	4742
	ATATGCTACTTTTAACA	4743
	TGTTAAAAGTAGCATAT	4744
20 Triazine Resistant D1 Protein <i>Zea mays</i> Ser264Thr AGT-ACT	AGACTTATAATATTGTGGCTGCTCACGGTTATTTTGGTCGATTAAT CTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACACTTCTTCT TGGCTGCTTGGCCTGTAGTAGGGATCTG	4745
	CAGATCCCTACTACAGGCCAAGCAGCCAAGAAGAAGTGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATTAATCGACCAAAT AACCGTGAGCAGCCACAATATTATAAGTCT	4746
	ATATGCTACTTTCAACA	4747
	TGTTGAAAGTAGCATAT	4748
25 Triazine Resistant D1 Protein <i>Arabidopsis thaliana</i> Ser264Thr AGT-ACT	AAACTTACAACATTGTAGCTGCTCACGGTTATTTTGGCCGATTGAT TTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACATTTCTTCTT AGCGGCTTGGCCGGTAGTAGGTATTTG	4749
	CAAATACCTACTACCGGCCAAGCCGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATGTTGTAAGTTT	4750
	ATATGCTACTTTCAACA	4751
	TGTTGAAAGTAGCATAT	4752

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Triazine Resistant D1 Protein <i>Picea abies</i> Ser264Thr AGT-ACT	AAACCTACAATATTGTGGCTGCTCACGGTTATTTGGCCGATTGAT CTTCCAGTATGCTACTTTCAACAACCTCCGTTCTTTACATTTCTTCT TAGCTGCTTGGCCCGTAGCAGGTATCTG	4753
	CAGATACCTGCTACGGGCCAAGCAGCTAAGAAGAAATGTAAAGAA CGGGAGTTGTTGAAAGTAGCATACTGGAAGATCAATCGGCCGAAA TAACCGTGAGCAGCCACAATATTGTAGGTTT	4754
	GTATGCTACTTTCAACA	4755
	TGTTGAAAGTAGCATAC	4756
10 Triazine Resistant D1 Protein <i>Vicia faba</i> Ser264Thr AGT-ACT	AAACCTATAATATTGTAGCTGCTCACGGTTATTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAATTCTCGCTCTTTACATTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4757
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAATGTAAAGAG CGAGAATTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATATTATAGGTTT	4758
	ATATGCTACTTTCAACA	4759
	TGTTGAAAGTAGCATAT	4760
15 Triazine Resistant D1 Protein <i>Hordeum vulgare</i> Ser264Thr AGT-ACT	AGACTTATAATATTGTGGCTGCTCATGGTTATTTGGCCGATTAAT CTTCCAATATGCTACTTTCAACAACCTCTCGTTCTTTACACTTCTTCT TGGCTGCTTGGCCTGTAGTAGGAATCTG	4761
	CAGATTCCTACTACAGGCCAAGCAGCCAAGAAGAAGTGTAAGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATTAATCGGCCAAAAT AACCATGAGCAGCCACAATATTATAAGTCT	4762
	ATATGCTACTTTCAACA	4763
	TGTTGAAAGTAGCATAT	4764
20 Triazine Resistant D1 Protein <i>Triticum aestivum</i> Ser264Thr AGT-ACT	AAACTTATAATATTGTGGCTGCTCATGGTTATTTGGCCGATTAAT CTTCCAATATGCTACTTTCAACAACCTCTCGTTCTTTACACTTCTTCT TGGCTGCTTGGCCTGTAGTAGGAATCTG	4765
	CAGATTCCTACTACAGGCCAAGCAGCCAAGAAGAAGTGTAAGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATTAATCGGCCAAAAT AACCATGAGCAGCCACAATATTATAAGTTT	4766
	ATATGCTACTTTCAACA	4767
	TGTTGAAAGTAGCATAT	4768
25 Triazine Resistant D1 Protein <i>Vigna unguiculata</i> Ser264Thr AGT-ACT	AAACTTATAATATTGTAGCTGCTCATGGTTATTTGGCCGATTAATC TTCCAATATGCAACTTTCAACAATTCTCGTTCTTTACATTTCTTCT AGCTGCTTGGCCTGTAGTAGGTATTTG	4769
	CAAATACCTACTACAGGCCAAGCAGCTAGGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTTGCATATTGGAAGATTAATCGGCCAAAAT AACCATGAGCAGCTACAATATTATAAGTTT	4770
	ATATGCAACTTTCAACA	4771
	TGTTGAAAGTTGCATAT	4772

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Triazine Resistant D1 Protein <i>Lotus japonicus</i> Ser264Thr AGT-ACT	AAACCTATAATATTGTAGCTGCTCACGGTTATTTTGGCCGATTGAT CTTCCAATATGCAACTTTCAACAACCTCTCGTTCTTTACACTTCTTCT TAGCTGCTTGGCCTGTTGTAGGTATCTG	4773
	CAGATACCTACAACAGGCCAAGCAGCTAAGAAGAAGTGTAAGAA CGAGAGTTGTTGAAAGTTGCATATTGGAAGATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATATTATAGGTTT	4774
	ATATGCAACTTTCAACA	4775
	TGTTGAAAGTTGCATAT	4776
10 Triazine Resistant D1 Protein <i>Sinapis alba</i> Ser264Thr AGT-ACT	AAACTTACAACATTGTAGCTGCTCACGGTTATTTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAATTCTCGTTCTTTACATTCTTCT TAGCGGCTTGGCCGGTAGTAGGTATTTG	4777
	CAAATACCTACTACCGGCCAAGCCGCTAAGAAGAAATGTAAAGAA CGAGAATTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATGTTGTAAGTTT	4778
	ATATGCTACTTTCAACA	4779
	TGTTGAAAGTAGCATAT	4780
15 Triazine Resistant D1 Protein <i>Pisum sativum</i> Ser264Thr AGT-ACT	AAACCTATAATATTGTAGCTGCTCACGGTTATTTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAATTCTCGCTCTTTACATTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4781
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAATGTAAAGAG CGAGAATTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT AACCGTGAGCAGCTACAATATTATAGGTTT	4782
	ATATGCTACTTTCAACA	4783
	TGTTGAAAGTAGCATAT	4784
20 Triazine Resistant D1 Protein <i>Spinacia oleracea</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCTGCTCATGGTTATTTTGGTCGATTGAT CTTCCAATATGCTACTTTCAACAACCTCTCGTTCTTTACACTTCTTCT TAGCTGCTTGGCCTGTAGTAGGTATTTG	4785
	CAAATACCTACTACAGGCCAAGCAGCTAAGAAGAAGTGTAAGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGACCAAAAT AACCATGAGCAGCTACGATATTATAAGTTT	4786
	ATATGCTACTTTCAACA	4787
	TGTTGAAAGTAGCATAT	4788
25 Triazine Resistant D1 Protein <i>Nicotiana debneyi</i> Ser264Thr AGT-ACT	AAACTTATAACATCGTAGCCGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAACCTCTCGTTCTTTACACTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4789
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAGTGTAACGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAAT TAACCATGAGCGGCTACGATGTTATAAGTTT	4790
	ATATGCTACTTTCAACA	4791
	TGTTGAAAGTAGCATAT	4792

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Triazine Resistant D1 Protein <i>Solanum nigrum</i> Ser264Thr AGT-ACT	AAACTTATAATATCGTAGCCGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAACTCTCGTTCGTTACACTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4793
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAGTGTAACGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCGGCTACGATATTATAAGTTT	4794
	ATATGCTACTTTCAACA	4795
	TGTTGAAAGTAGCATAT	4796
10 Triazine Resistant D1 Protein <i>Nicotiana plumbaginifolia</i> Ser264Thr AGT-ACT	AAACTTATAACATCGTAGCCGCTCATGGTTATTTTGGCCGATTGAT CTTCCAATATGCTACTTTCAACAACTCTCGTTCGTTACACTTCTTCC TAGCTGCTTGGCCTGTAGTAGGTATCTG	4797
	CAGATACCTACTACAGGCCAAGCAGCTAGGAAGAAGTGTAACGAA CGAGAGTTGTTGAAAGTAGCATATTGGAAGATCAATCGGCCAAAA TAACCATGAGCGGCTACGATGTTATAAGTTT	4798
	ATATGCTACTTTCAACA	4799
	TGTTGAAAGTAGCATAT	4800

Example 6
Engineering male- or female-sterile plants

Flower development in distantly related dicot plant species is increasingly better understood and appears to be regulated by a family of genes which encode regulatory proteins. These genes include, for example, *AGAMOUS* (*AG*), *APETALA1* (*AP1*), and *APETALA3* (*AP3*) and *PISTILLATA* (*PI*) in *Arabidopsis thaliana*, and *DEFICIENS A* (*DEFA*), *GLOBOSA* (*GLO*), *SQUAMOSA* (*SQUA*), and *PLENA* (*PLE*) in *Antirrhinum majus*. Genetic studies have shown that the *DEFA*, *GLO* and *AP3* genes are essential for petal and stamen development. Sequence analysis of these genes revealed that the gene products contain a conserved MADS box region, a DNA-binding domain. Using these clones as probes, MADS box genes have also been isolated from other species including tomato, tobacco, petunia, *Brassica napus*, and maize.

Altering the expression of these genes results in altered floral morphology. For example, mutations in *AP3* and *PI* result in male-sterile flowers because petals develop in place of stamens.

The attached tables disclose exemplary oligonucleotide base sequences which can be used to generate site-specific mutations that confer altered floral structures in plants.

Table 14
Oligonucleotides to produce male-sterile plants

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Male-sterile AP3 <i>Arabidopsis thaliana</i> Arg3Term AGA-TGA	TTGTCCTCTCCACCAAATCTCTTCAACAAAAAGATTAAACAAAGAGA GAAGAATATGGCGTIGAGGGAAGATCCAGATCAAGAGGATAGAGAA CCAGACAAACAGACAAGTGACGTATTCAA	4801
	TTGAATACGTCACTTGTCTGTTTGTCTGGTTCTCTATCCTCTTGATC TGGATCTTCCCTCAGCCATATTCTTCTCTCTTTGTTAATCTTTTT GTTGAAGAGATTTGGTGGAGAGGACAA	4802
	ATATGGCGTIGAGGGAAG	4803
	CTTCCCTCAGCCATAT	4804
Male-sterile AP3 <i>Arabidopsis thaliana</i> Lys5Term AAG-TAG	TCTCCACCAAATCTCTTCAACAAAAAGATTAAACAAAGAGAGAAGA ATATGGCGAGAGGGTAGATCCAGATCAAGAGGATAGAGAACCGAGA CAACAGACAAGTGACGTATTCAAAGAGAA	4805
	TTCTCTTTGAATACGTCACTTGTCTGTTTGTCTGGTTCTCTATCCTC TTGATCTGGATCTACCTCTCGCCATATTCTTCTCTCTTTGTTAAT CTTTTTGTTGAAGAGATTTGGTGGAGA	4806
	CGAGAGGGTAGATCCAG	4807

		CTGGATCT <u>ACCCTCTCG</u>	4808
5	Male-sterile AP3 <i>Arabidopsis thaliana</i> Gln7Term CAG-TAG	CCAAATCTCTTCAACAAAAAGATTAAACAAAGAGAGAAGAATATGG CGAGAGGGAAGATCTAGATCAAGAGGATAGAGAACCAGACAAACA GACAAGTGACGTATTCAAAGAGAAGGAATG	4809
		CATTCTTCTCTTTGAATACGTCACTTGTCTGTTTGTCTGGTTCTCT ATCCTCTTGATCTAGATCTTCCCTCTCGCCATATTCTTCTCTCTTTG TTAATCTTTTTGTTGAAGAGATTGG	4810
		GGAAGATCTAGATCAAG	4811
		CTTGATCTAGATCTTCC	4812
10	Male-sterile AP3 <i>Arabidopsis thaliana</i> Lys9Term AAG-TAG	CTCTTCAACAAAAAGATTAAACAAAGAGAGAAGAATATGGCGAGAG GGAAGATCCAGATCTAGAGGATAGAGAACCAGACAAACAGACAAG TGACGTATTCAAAGAGAAGGAATGGTTTAT	4813
		ATAAACCATTCTTCTCTTTGAATACGTCACTTGTCTGTTTGTCTGG TTCTCTATCCTCTAGATCTGGATCTTCCCTCTCGCCATATTCTTCTC TCTTTGTTAATCTTTTTGTTGAAGAG	4814
		TCCAGATCTAGAGGATA	4815
		TATCCTCTAGATCTGGA	4816
15	Male-sterile AP3 <i>Brassica oleracea</i> Lys23Term AAG-TAG	AGAGGGAAGATCCAGATCAAGAGGATAGAGAACCAGACCAACCGA CAAGTGACGTATTCTTAGAGAAGAAATGGTTTGTTCAAGAAAGCTC ACGAGCTTACAGTTTTATGTGATGCTAGGG	4817
		CCCTAGCATCACATAAACTGTAAGCTCGTGAGCTTTCTTGAACAA ACCATTTCTTCTCTAGAATACGTCACTTGTGCGTTGGTCTGGTTC TCTATCCTCTTGATCTGGATCTTCCCTCT	4818
		CGTATTCTTAGAGAAGA	4819
		TCTTCTCTAGAATACG	4820
20	Male-sterile AP3 <i>Brassica oleracea</i> Arg24Term AGA-TGA	GGGAAGATCCAGATCAAGAGGATAGAGAACCAGACCAACCGACAA GTGACGTATTCTAAGTGAAGAAATGGTTTGTTCAAGAAAGCTCACG AGCTTACAGTTTTATGTGATGCTAGGGTTT	4821
		AAACCCTAGCATCACATAAACTGTAAGCTCGTGAGCTTTCTTGAA CAAACCATTTCTTCACTTAGAATACGTCACTTGTGCGTTGGTCTGG TTCTCTATCCTCTTGATCTGGATCTTCCC	4822
		ATTCTAAGTGAAGAAAT	4823
		ATTTCTTCACTTAGAAT	4824
25	Male-sterile AP3 <i>Brassica oleracea</i> Arg25Term AGA-TGA	AAGATCCAGATCAAGAGGATAGAGAACCAGACCAACCGACAAGTG ACGTATTCTAAGAGATGAAATGGTTTGTTCAAGAAAGCTCACGAGC TTACAGTTTTATGTGATGCTAGGGTTTCGA	4825
		TCGAAACCCTAGCATCACATAAACTGTAAGCTCGTGAGCTTTCTT GAACAAACCATTTCTCTCTTAGAATACGTCACTTGTGCGTTGGTC TGGTTCTCTATCCTCTTGATCTGGATCTT	4826
		CTAAGAGATGAAATGGT	4827
		ACCATTTCTCTCTTAG	4828

5	Male-sterile AP3 <i>Brassica oleracea</i> Leu28Term TTG-TAG	TCAAGAGGATAGAGAACCAGACCAACCGACAAGTGACGTATTCTA AGAGAAGAAATGGTTAGTTCAAGAAAGCTCACGAGCTTACAGTTTT ATGTGATGCTAGGGTTTCGATTATCATGTT	4829
		AACATGATAATCGAAACCTAGCATCACATAAAACTGTAAGCTCGT GAGCTTTCTTGAACTAACCATTTCTTCTCTTAGAATACGTCACTTGT CGGTTGGTCTGGTTCTCTATCCTCTTGA	4830
		AAATGGTTAGTTCAAGA	4831
		TCTTGAACTAACCATTT	4832
10	Male-sterile AP3 <i>Brassica napus</i> Tyr21Term TAC-TAG	GGCTCGAGGGAAGATCCAGATTAAGAGGATAGAGAACCAAACAAA CAGGCAGGTCACCTAGTCCAAGAGAAGAAATGGTTTGTTCAAGAA AGCACACGAGCTCTCTGTTCTCTGTGATGCT	4833
		AGCATCACAGAGAACAGAGAGCTCGTGTGCTTTCTTGAACAAACC ATTTCTTCTCTTGGACTAGGTGACCTGCCTGTTGTTGGTTCTCTA TCCTCTTAATCTGGATCTTCCCTCGAGCC	4834
		GTCACCTAGTCCAAGAG	4835
		CTCTTGGACTAGGTGAC	4836
15	Male-sterile AP3 <i>Brassica napus</i> Lys23Term AAG-TAG	CGAGGGAAGATCCAGATTAAGAGGATAGAGAACCAAACAAACAGG CAGGTCACCTACTCCTAGAGAAGAAATGGTTTGTTCAAGAAAGCAC ACGAGCTCTCTGTTCTCTGTGATGCTAAAG	4837
		CTTTAGCATCACAGAGAACAGAGAGCTCGTGTGCTTTCTTGAACAA ACCATTTCTTCTCTAGGAGTAGGTGACCTGCCTGTTGTTGGTTC TCTATCCTCTTAATCTGGATCTTCCCTCG	4838
		CCTACTCCTAGAGAAGA	4839
		TCTTCTCTAGGAGTAGG	4840
20	Male-sterile AP3 <i>Brassica napus</i> Arg24Term AGA-TGA	GGGAAGATCCAGATTAAGAGGATAGAGAACCAAACAAACAGGCAG GTCACCTACTCCAAGTGAAGAAATGGTTTGTTCAAGAAAGCACACG AGCTCTCTGTTCTCTGTGATGCTAAAGTTT	4841
		AAACTTTAGCATCACAGAGAACAGAGAGCTCGTGTGCTTTCTTGAA CAAACCATTTCTTCACTTGGAGTAGGTGACCTGCCTGTTGTTGG TTCTCTATCCTCTTAATCTGGATCTTCCC	4842
		ACTCCAAGTGAAGAAAT	4843
		ATTTCTTCACTTGGAGT	4844
25	Male-sterile AP3 <i>Brassica napus</i> Arg25Term AGA-TGA	AAGATCCAGATTAAGAGGATAGAGAACCAAACAAACAGGCAGGTC ACCTACTCCAAGAGATGAAATGGTTTGTTCAAGAAAGCACACGAGC TCTCTGTTCTCTGTGATGCTAAAGTTTCCA	4845
		TGGAACTTTAGCATCACAGAGAACAGAGAGCTCGTGTGCTTTCTT GAACAAACCATTTCATCTCTTGGAGTAGGTGACCTGCCTGTTTGTT TGGTTCTCTATCCTCTTAATCTGGATCTT	4846
		CCAAGAGATGAAATGGT	4847
		ACCATTTCACTCTTGG	4848

5	Male-sterile DEFA <i>Antirrhinum majus</i> Arg3Term CGA-TGA	GGAGAGAAAGGAAAGCTGGAAGAAGAAAACAAGAGCAGTAGTGGT AGTGGTTCGATGGCTIGAGGGAAGATCCAGATTAAGAGGATAGAG AACCAAACAAACAGGCAGGTCACCTACTCCA	4849
		TGGAGTAGGTGACCTGCCTGTTTGTTTGGTTCTCTATCCTCTTAAT CTGGATCTTCCCTCAAGCCATCGAACCCTACCCTACTGCTCTTG TTTTCTTCTTCCAGCTTTCCTTCTCTCC	4850
		CGATGGCTIGAGGGAAG	4851
		CTTCCCTCAAGCCATCG	4852
10	Male-sterile DEFA <i>Antirrhinum majus</i> Lys5Term AAG-TAG	AAAGGAAAGCTGGAAGAAGAAAACAAGAGCAGTAGTGGTAGTGGT TCGATGGCTCGAGGGTAGATCCAGATTAAGAGGATAGAGAACCAA ACAAACAGGCAGGTCACCTACTCCAAGAGAA	4853
		TTCTCTTGGAGTAGGTGACCTGCCTGTTTGTTTGGTTCTCTATCCT CTTAATCTGGATCTACCCTCGAGCCATCGAACCCTACCCTACTG CTCTTGTTTTCTTCTTCCAGCTTTCCTTT	4854
		CTCGAGGGTAGATCCAG	4855
		CTGGATCTACCCTCGAG	4856
15	Male-sterile DEFA <i>Antirrhinum majus</i> Gln7Term CAG-TAG	AAGCTGGAAGAAGAAAACAAGAGCAGTAGTGGTAGTGGTTCGATG GCTCGAGGGAAGATCTAGATTAAGAGGATAGAGAACCAAACAAAC AGGCAGGTCACCTACTCCAAGAGAAGAAATG	4857
		CATTCTTCTCTTGGAGTAGGTGACCTGCCTGTTTGTTTGGTTCTC TATCCTCTTAATCTAGATCTTCCCTCGAGCCATCGAACCCTACCA CTACTGCTCTTGTTTTCTTCTTCCAGCTT	4858
		GGAAGATCTAGATTAAG	4859
		CTTAATCTAGATCTTCC	4860
20	Male-sterile DEFA <i>Antirrhinum majus</i> Lys9Term AAG-TAG	GAAGAAGAAAACAAGAGCAGTAGTGGTAGTGGTTCGATGGCTCGA GGGAAGATCCAGATTAGAGGATAGAGAACCAAACAAACAGGCAG GTCACCTACTCCAAGAGAAGAAATGGTTTGT	4861
		ACAAACCATTTCTTCTTGGAGTAGGTGACCTGCCTGTTTGTTTG GTTCTCTATCCTCTAAATCTGGATCTTCCCTCGAGCCATCGAACCA CTACCACTACTGCTCTTGTTTTCTTCTTC	4862
		TCCAGATTAGAGGATA	4863
		TATCCTCTAAATCTGGA	4864
25	Male-sterile AP3 <i>Nicotiana tabacum</i> Lys5Term AAG-TAG	TCAGTAATTCTTAAGATCTCAAACTTTGAGCAAAAAGAAAAAAAC TATGGCTCGTGGGTAGATCCAGATCAAGAGAATAGAGAACCAAAC AAACAGACAAGTCACTTATTCTAAGAGAA	4865
		TTCTCTAGAATAAGTGACTTGTCTGTTTGTTTGGTTCTCTATTCTC TTGATCTGGATCTACCCACGAGCCATAGTTTTTTTTCTTTTTGCTC AAAGTTTGAGATCTTAAGAATTACTGA	4866
		CTCGTGGGTAGATCCAG	4867
		CTGGATCTACCCACGAG	4868

5	Male-sterile AP3 <i>Nicotiana tabacum</i> Gln7Term CAG-TAG	ATTCTTAAGATCTCAAACCTTTGAGCAAAAAGAAAAAACTATGGC	4869
		TCGTGGGAAGATCTAGATCAAGAGAATAGAGAACCAACAAACAGA	
		CAAGTCACTTATTCTAAGAGAAGAAATG	
		CATTCTTCTCTTAGAATAAGTGACTTGTCTGTTTGTTGGTTCTCT	4870
		ATTCTCTTGATCTAGATCTTCCCACGAGCCATAGTTTTTTTTCTTT	
10	Male-sterile AP3 <i>Nicotiana tabacum</i> Lys9Term AAG-TAG	TTGCTCAAAGTTTGAGATCTTAAGAAT	
		GGAAGATCTAGATCAAG	4871
		CTTGATCTAGATCTTCC	4872
		AAGATCTCAAACCTTTGAGCAAAAAGAAAAAACTATGGCTCGTG	4873
		GGAAGATCCAGATCTAGAGAATAGAGAACCAACAAACAGACAAGT	
15	Male-sterile AP3 <i>Nicotiana tabacum</i> Arg10Term AGA-TGA	CACTTATTCTAAGAGAAGAAATGGACTTT	
		AAAGTCCATTTCTTCTCTTAGAATAAGTGACTTGTCTGTTTGTTGG	4874
		TTCTCTATTCTCTAGATCTGGATCTTCCCACGAGCCATAGTTTTTT	
		TTCTTTTTGCTCAAAGTTTGAGATCTT	
		TCCAGATCTAGAGAATA	4875
20	Male-sterile AP3 <i>Medicago sativa</i> Tyr21Term TAC-TAG	TATTCTCTAGATCTGGA	4876
		ATCTCAAACCTTTGAGCAAAAAGAAAAAACTATGGCTCGTGGA	4877
		AGATCCAGATCAAGTGAATAGAGAACCAACAAACAGACAAGTCAC	
		TTATTCTAAGAGAAGAAATGGACTTTTCA	
		TGAAAAGTCCATTTCTTCTCTTAGAATAAGTGACTTGTCTGTTTGTT	4878
25	Male-sterile AP3 <i>Medicago sativa</i> Ser22Term TCA-TGA	TGGTTCTCTATTCACTTGATCTGGATCTTCCCACGAGCCATAGTTT	
		TTTTTCTTTTTGCTCAAAGTTTGAGAT	
		AGATCAAGTGAATAGAG	4879
		CTCTATTCACTTGATCT	4880
		GGCTCGAGGAAAGATCCAGATCAAGAGAATAGAGAACACAACGAA	4881
		CAGACAAGTAACTTAGTCAAAACGAAGGGATGGTCTTTTCAAGAAG	
		GCCAATGAGCTCACTGTTCTTTGTGATGCT	
		AGCATCACAAAGAACAGTGAGCTCATTGGCCTTCTTGAAAAGACCA	4882
		TCCCTTCGTTTTGACTAAGTTACTTGTCTGTTTCGTTGTGTTCTCTAT	
		TCTCTTGATCTGGATCTTTCCTCGAGCC	
		GTAACCTAGTCAAAACG	4883
		CGTTTTGACTAAGTTAC	4884
		CTCGAGGAAAGATCCAGATCAAGAGAATAGAGAACACAACGAACA	4885
		GACAAGTAACTTACTGAAAACGAAGGGATGGTCTTTTCAAGAAGGC	
		CAATGAGCTCACTGTTCTTTGTGATGCTAA	
		TTAGCATCACAAAGAACAGTGAGCTCATTGGCCTTCTTGAAAAGAC	4886
		CATCCCTTCGTTTTCAGTAAGTTACTTGTCTGTTTCGTTGTGTTCTCT	
		ATTCTCTTGATCTGGATCTTTCCTCGAG	
		AACTTACTGAAAACGAA	4887
		TTTCGTTTTCAGTAAGTT	4888

5	Male-sterile AP3 <i>Medicago sativa</i> Lys23Term AAA-TAA	CGAGGAAAGATCCAGATCAAGAGAATAGAGAACACAACGAACAGA CAAGTAACTTACTCATAACGAAGGGATGGTCTTTTCAAGAAGGCCA ATGAGCTCACTGTTCTTTGTGATGCTAAGG	4889
		CCTTAGCATCACAAAGAACAGTGAGCTCATTGGCCTTCTTGAAAAG ACCATCCCTTCGTTATGAGTAAGTTACTTGTCTGTTGTTCT CTATTCTCTTGATCTGGATCTTCTCG	4890
		CTTACTCATAACGAAGG	4891
		CCTTCGTTATGAGTAAG	4892
10	Male-sterile AP3 <i>Medicago sativa</i> Arg24Term CGA-TGA	GGAAAGATCCAGATCAAGAGAATAGAGAACACAACGAACAGACAA GTAACCTTACTCAAAATGAAGGGATGGTCTTTTCAAGAAGGCCAATG AGCTCACTGTTCTTTGTGATGCTAAGGTTT	4893
		AAACCTTAGCATCACAAAGAACAGTGAGCTCATTGGCCTTCTTGAA AAGACCATCCCTTCATTTTGAGTAAGTTACTTGTCTGTTGTTGT TCTCTATTCTCTTGATCTGGATCTTCC	4894
		ACTCAAAATGAAGGGAT	4895
		ATCCCTTCATTTTGAGT	4896
15	Male-sterile DEF4 <i>Solanum tuberosum</i> Tyr21Term TAT-TAG	GGCTCGTGGTAAGATCCAGATCAAGAAAATAGAAAACCAAACAAAT AGGCAAGTGACTTAGTCAAAGAGAAGAAATGGGCTATTCAAGAAG GCTAATGAACCTACAGTTCTTTGTGATGCT	4897
		AGCATCACAAAGAACTGTAAGTTCATTAGCCTTCTTGAATAGCCCA TTTCTTCTCTTTGACTAAGTCACTTGCCTATTTGTTTGGTTTTCTATT TTCTTGATCTGGATCTTACCACGAGCC	4898
		GTGACTTAGTCAAAGAG	4899
		CTCTTTGACTAAGTCAC	4900
20	Male-sterile DEF4 <i>Solanum tuberosum</i> Ser22Term TCA-TGA	CTCGTGGTAAGATCCAGATCAAGAAAATAGAAAACCAAACAAATAG GCAAGTGACTTATTGAAAGAGAAGAAATGGGCTATTCAAGAAGGCT AATGAACTTACAGTTCTTTGTGATGCTAA	4901
		TTAGCATCACAAAGAACTGTAAGTTCATTAGCCTTCTTGAATAGCC CATTTCTTCTCTTCAATAAGTCACTTGCCTATTTGTTTGGTTTTCTA TTTTCTTGATCTGGATCTTACCACGAG	4902
		GACTTATTGAAAGAGAA	4903
		TTCTCTTCAATAAGTC	4904
25	Male-sterile DEF4 <i>Solanum tuberosum</i> Lys23Term AAG-TAG	CGTGGTAAGATCCAGATCAAGAAAATAGAAAACCAAACAAATAGGC AAGTGACTTATTCAAGAGAAGAAATGGGCTATTCAAGAAGGCTAA TGAACCTTACAGTTCTTTGTGATGCTAAAG	4905
		CTTTAGCATCACAAAGAACTGTAAGTTCATTAGCCTTCTTGAATAGC CCATTTCTTCTCTATGAATAAGTCACTTGCCTATTTGTTTGGTTTTCT TATTTCTTGATCTGGATCTTACCACG	4906
		CTTATTCATAGAGAAGA	4907
		TCTTCTCTATGAATAAG	4908

5	Male-sterile DEF4 <i>Solanum tuberosum</i> Arg24Term AGA-TGA	GGTAAGATCCAGATCAAGAAAATAGAAAACCAAACAAATAGGCAAG TGACTTATTCAAAGTGAAGAAATGGGCTATTCAAGAAGGCTAATGA ACTTACAGTTCTTTGTGATGCTAAAGTTT	4909
		AAACTTTAGCATCACAAAGAACTGTAAGTTCATTAGCCTTCTTGAAT AGCCCATTTCTTCACTTTGAATAAGTCACTTGCCTATTTGTTGGTT TTCTATTTTCTTGATCTGGATCTTACC	4910
		ATTCAAAGTGAAGAAAT	4911
		ATTTCTTCACTTTGAAT	4912
10	Male-sterile AP3 <i>Lycopersicon esculentum</i> Gly27Term GGA-TGA	GCTAATGAACCTACTGTTCTTTGTGATGCTAAAGTTTCAATTGTTAT GATTTCTAGTACTTGAAGAACTTCATGAGTTTATAAGTCCCTCTATCA CGACCAAACAATTGTTGATCTGTACC	4913
		GGTACAGATCGAACAATTGTTTGGTCGTGATAGAGGGACTTATAAA CTCATGAAGTTTCAAGTACTAGAAATCATAACAATTGAACTTTAG CATCACAAAGAACAGTAAGTTCATTAGC	4914
		CTAGTACTTGAAGAACTT	4915
		AAGTTTTCAAGTACTAG	4916
15	Male-sterile AP3 <i>Lycopersicon esculentum</i> Lys28Term AAA-TAA	AATGAACCTACTGTTCTTTGTGATGCTAAAGTTTCAATTGTTATGAT TTCTAGTACTGGATAACTTCATGAGTTTATAAGTCCCTCTATCACGA CCAAACAATTGTTGATCTGTACCAGA	4917
		TCTGGTACAGATCGAACAATTGTTTGGTCGTGATAGAGGGACTTAT AAACTCATGAAGTTATCCAGTACTAGAAATCATAACAATTGAACTT TAGCATCACAAAGAACAGTAAGTTCATT	4918
		GTAAGTGGATAACTTCAT	4919
		ATGAAGTTATCCAGTAC	4920
20	Male-sterile AP3 <i>Lycopersicon esculentum</i> Glu31Term GAG-TAG	ACTGTTCTTTGTGATGCTAAAGTTTCAATTGTTATGATTTCTAGTAC TGGAAACTTCATTAGTTTATAAGTCCCTCTATCACGACCAAACAAT TGTTGATCTGTACCAGAAGACTATTG	4921
		CAATAGTCTTCTGGTACAGATCGAACAATTGTTTGGTCGTGATAGA GGGACTTATAAACTAATGAAGTTTTCCAGTACTAGAAATCATAACAA TTGAAACTTTAGCATCACAAAGAACAGT	4922
		AACCTCATTAGTTTATA	4923
		TATAAACTAATGAAGTT	4924
25	Male-sterile AP3 <i>Lycopersicon esculentum</i> Lys40Term AAA-TAA	ATTGTTATGATTTCTAGTACTGGAAACTTCATGAGTTTATAAGTCC CTCTATCACGACCTAACAATTGTTGATCTGTACCAGAAGACTATT GGAGTTGATATTTGGACTACTCACTATG	4925
		CATAGTGAGTAGTCCAAATATCAACTCCAATAGTCTTCTGGTACAG ATCGAACAATTGTTAGGTCGTGATAGAGGGACTTATAAACTCATGA AGTTTTCCAGTACTAGAAATCATAACAAT	4926
		TCACGACCTAACAATTG	4927
		CAATTGTTAGGTCGTGA	4928

5	Male-sterile AP3 <i>Triticum aestivum</i> Tyr21Term TAC-TAG	GGGGCGGGGAAGATTGAGATAAAGCGGATCGAGAACGCCACCA ACAGGCAGGTGACCTAGTCCAAGCGCCGGTCGGGGATCATGAAG AAGGCGCGGGAGCTCACCCTGCTCTGCGACGCC	4929
		GGCGTCGCAGAGCACGGTGAGCTCCCGCGCCTTCTTCATGATCC CCGACCGGCGCTTGGACTAGGTACCTGCCTGTTGGTGGCGTTC TCGATCCGCTTTATCTCAATCTTCCCCCGCCCC	4930
		GTGACCTAGTCCAAGCG	4931
		CGCTTGGACTAGGTCAC	4932
10	Male-sterile AP3 <i>Triticum aestivum</i> Lys23Term AAG-TAG	CGGGGAAGATTGAGATAAAGCGGATCGAGAACGCCACCAACAG GCAGGTGACCTACTCCTAGCGCCGGTCGGGGATCATGAAGAAGG CGCGGGAGCTCACCCTGCTCTGCGACGCCCAGG	4933
		CCTGGGCGTCGCAGAGCACGGTGAGCTCCCGCGCCTTCTTCATG ATCCCCGACCGGCGCTAGGAGTAGGTACCTGCCTGTTGGTGGC GTTCTCGATCCGCTTTATCTCAATCTTCCCCCG	4934
		CCTACTCCTAGCGCCGG	4935
		CCGGCGCTAGGAGTAGG	4936
15	Male-sterile AP3 <i>Triticum aestivum</i> Ser26Term TCG-TAG	TTGAGATAAAGCGGATCGAGAACGCCACCAACAGGCAGGTGACCT ACTCCAAGCGCCGGTAGGGGATCATGAAGAAGGCGCGGGAGCTC ACCGTGCTCTGCGACGCCCAGGTGCCATCAT	4937
		ATGATGGCGACCTGGGCGTCGCAGAGCACGGTGAGCTCCCGCGC CTTCTTCATGATCCCCIACCGGCGCTTGGAGTAGGTACCTGCCT GTTGGTGGCGTTCTCGATCCGCTTTATCTCAA	4938
		GCGCCGGTAGGGGATCA	4939
		TGATCCCCIACCGGCGC	4940
20	Male-sterile AP3 <i>Triticum aestivum</i> Lys30Term AAG-TAG	CGGATCGAGAACGCCACCAACAGGCAGGTGACCTACTCCAAGCG CCGGTCGGGGATCATGTAGAAGGCGCGGGAGCTCACCCTGCTCT GCGACGCCCAGGTGCCATCATCATGTTCTCCT	4941
		AGGAGAACATGATGATGGCGACCTGGGCGTCGCAGAGCACGGTG AGCTCCCGCGCCTTCTACATGATCCCCGACCGGCGCTTGGAGTA GGTCACCTGCCTGTTGGTGGCGTTCTCGATCCG	4942
		GGATCATGTAGAAGGCG	4943
		CGCCTTCTACATGATCC	4944
25	Male-sterile Silky1 <i>Zea mays</i> Tyr21Term TAC-TAG	GGGGCGCGGAAGATCGAGATCAAGCGGATCGAGAACGCCACCA ACCGCCAGGTGACCTAGTCCAAGCGCCGGACGGGGATCATGAAG AAGGCACGCGAGCTCACCCTGCTCTGCGACGCC	4945
		GGCGTCGCAGAGCACGGTGAGCTCGCGTGCCTTCTTCATGATCC CCGTCCGGCGCTTGGACTAGGTACCTGGCGGTTGGTGGCGTTC TCGATCCGCTTGATCTCGATCTTGCCGCGCCCC	4946
		GTGACCTAGTCCAAGCG	4947
		CGCTTGGACTAGGTCAC	4948

5	Male-sterile Silky1 <i>Zea mays</i> Lys23Term AAG-TAG	CGCGGCAAGATCGAGATCAAGCGGATCGAGAACGCCACCAACCG CCAGGTGACCTACTCCTAGCGCCGGACGGGGATCATGAAGAAGG CACGCGAGCTCACCGTGCTCTGCGACGCCCAGG	4949
		CCTGGGCGTCGCAGAGCACGGTGAGCTCGCGTGCCCTTCTTCATG ATCCCCGTCCGGCGCTAGGAGTAGGTCACCTGGCGGTTGGTGGC GTTCTCGATCCGCTTGATCTCGATCTTGCCGCG	4950
		CCTACTCCTAGCGCCGG	4951
		CCGGCGCTAGGAGTAGG	4952
10	Male-sterile Silky1 <i>Zea mays</i> Lys30Term AAG-TAG	CGGATCGAGAACGCCACCAACCGCCAGGTGACCTACTCCAAGCG CCGGACGGGGATCATGTAGAAGGCACGCGAGCTCACCGTGCTCT GCGACGCCCAGGTCGCCATCATCATGTTCTCCT	4953
		AGGAGAACATGATGATGGCGACCTGGGCGTCGCAGAGCACGGTG AGCTCGCGTGCCCTTCTACATGATCCCCGTCCGGCGCTTGAGTAG GTCACCTGGCGGTTGGTGGCGTTCTCGATCCG	4954
		GGATCATGTAGAAGGCA	4955
		TGCCCTTCTACATGATCC	4956
15	Male-sterile Silky1 <i>Zea mays</i> Lys31Term AAG-TAG	ATCGAGAACGCCACCAACCGCCAGGTGACCTACTCCAAGCGCCG GACGGGGATCATGAAGTAGGCACGCGAGCTCACCGTGCTCTGCG ACGCCCAGGTCGCCATCATCATGTTCTCCTCCA	4957
		TGGAGGAGAACATGATGATGGCGACCTGGGCGTCGCAGAGCACG GTGAGCTCGCGTGCCCTACTTCATGATCCCCGTCCGGCGCTTGGA GTAGGTCACCTGGCGGTTGGTGGCGTTCTCGAT	4958
		TCATGAAGTAGGCACGC	4959
		GCGTGCCCTACTTCATGA	4960
20	Male-sterile AP3 <i>Oryza sativa</i> Lys5Term AAG-TAG	GCTAGCTGCATTGTCCGGCGAGAGAGATAGCTGCTGCAGGGGGC GGCCATGGGGAGGGGCTAGATCGAGATCAAGCGGATCGAGAACG CGACCAACAGGCAGGTGACCTACTCGAAGCGCC	4961
		GGCGCTTCGAGTAGGTACCTGCCTGTTGGTCGCGTTCTCGATCC GCTTGATCTCGATCTAGCCCCCTCCCCATGGCCGCCCCCTGCAGC AGCTATCTCTCTCGCCGGACAATGCAGCTAGC	4962
		GGAGGGGCTAGATCGAG	4963
		CTCGATCTAGCCCCCTCC	4964
25	Male-sterile AP3 <i>Oryza sativa</i> Glu7Term GAG-TAG	TGCATTGTCCGGCGAGAGAGATAGCTGCTGCAGGGGGCGGCCAT GGGGAGGGGCAAGATCTAGATCAAGCGGATCGAGAACGCGACCA ACAGGCAGGTGACCTACTCGAAGCGCCGCACGG	4965
		CCGTGCGGCGCTTCGAGTAGGTACCTGCCTGTTGGTCGCGTTCT CGATCCGCTTGATCTAGATCTTGCCCCTCCCCATGGCCGCCCCCT GCAGCAGCTATCTCTCTCGCCGGACAATGCA	4966
		GCAAGATCTAGATCAAG	4967
		CTTGATCTAGATCTTGC	4968

5	Male-sterile AP3 <i>Oryza sativa</i> Lys9Term AAG-TAG	GTCCGGCGAGAGAGATAGCTGCTGCAGGGGGCGGCCATGGGGA GGGGCAAGATCGAGATCTAGCGGATCGAGAACGCGACCAACAGG CAGGTGACCTACTCGAAGCGCCGCACGGGGATCA	4969
		TGATCCCCGTGCGGCGCTTCGAGTAGGTCACCTGCCTGTTGGTC GCGTTCTCGATCCGCTAGATCTCGATCTTGCCCCTCCCCATGGCC GCCCCCTGCAGCAGCTATCTCTCGCCGGAC	4970
		TCGAGATCTAGCGGATC	4971
		GATCCGCTAGATCTCGA	4972
10	Male-sterile AP3 <i>Oryza sativa</i> Glu12Term GAG-TAG	GAGAGATAGCTGCTGCAGGGGGCGGCCATGGGGAGGGGCAAGA TCGAGATCAAGCGGATCTAGAACGCGACCAACAGGCAGGTGACCT ACTCGAAGCGCCGCACGGGGATCATGAAGAAGG	4973
		CCTTCTTCATGATCCCCGTGCGGCGCTTCGAGTAGGTCACCTGCC TGTTGGTCGCGTTCTAGATCCGCTTGATCTCGATCTTGCCCCCTCC CCATGGCCGCCCCCTGCAGCAGCTATCTCTC	4974
		AGCGGATCTAGAACGCG	4975
		CGCGTTCTAGATCCGCT	4976

Table 15
Oligonucleotides to produce male-sterile plants

15	Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
20	Male-sterile AG <i>Arabidopsis thaliana</i> Tyr35Term TAC-TAG	TCTGTACTAATCAAATTTTGCCCTAAACGTTTTTGGCTTTGGAGCA GCAATCACGGCGTAGCAATCGGAGCTAGGAGGAGATTCTCTCC CTTGAGGAAATCTGGGAGAGGAAAGATCGAA	4977
		TTCGATCTTTCTCTCCAGATTTCTCAAGGGAGAGGAATCTCCT CCTAGCTCCGATTGCTACGCCGTGATTGCTGCTCCAAAGCCAAAA ACGTTTAGGGCAAATTTGATTAGTACAGA	4978
		ACGGCGTAGCAATCGGA	4979
		TCCGATTGCTACGCCGT	4980
25	Male-sterile AG <i>Arabidopsis thaliana</i> Gln36Term CAA-TAA	CTGTACTAATCAAATTTTGCCCTAAACGTTTTTGGCTTTGGAGCAG CAATCACGGCGTACTAATCGGAGCTAGGAGGAGATTCTCTCCCT TGAGGAAATCTGGGAGAGGAAAGATCGAAA	4981
		TTTCGATCTTTCTCTCCAGATTTCTCAAGGGAGAGGAATCTCC TCCTAGCTCCGATTAGTACGCCGTGATTGCTGCTCCAAAGCCAAA AACGTTTAGGGCAAATTTGATTAGTACAG	4982
		CGGCGTACTAATCGGAG	4983
		CTCCGATTAGTACGCCG	4984

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Male-sterile AG <i>Arabidopsis thaliana</i> Ser37Term TCG-TAG	ACTAATCAAATTTTGGCCTAAACGTTTTGGCTTTGGAGCAGCAAT CACGGCGTACCAATAGGAGCTAGGAGGAGATTCTCTCCCTTGA GGAAATCTGGGAGAGGAAAGATCGAAATCAA	4985
	TTGATTTGATCTTTCTCTCCAGATTCTCTCAAGGGAGAGGAAT CTCCTCCTAGCTCCTATTGGTACGCCGTGATTGCTGCTCCAAAGC CAAAAACGTTTAGGGCAAATTTGATTAGT	4986
	GTACCAATAGGAGCTAG	4987
	CTAGCTCCTATTGGTAC	4988
10 Male-sterile AG <i>Arabidopsis thaliana</i> Glu38Term GAG-TAG	TAATCAAATTTTGGCCTAAACGTTTTGGCTTTGGAGCAGCAATCA CGGCGTACCAATCGTAGCTAGGAGGAGATTCTCTCCCTTGAGGA AATCTGGGAGAGGAAAGATCGAAATCAAAC	4989
	GTTTGATTTGATCTTTCTCTCCAGATTCTCTCAAGGGAGAGGA ATCTCCTCCTAGCTACGATTGGTACGCCGTGATTGCTGCTCCAAA GCCAAAACGTTTAGGGCAAATTTGATTA	4990
	ACCAATCGTAGCTAGGA	4991
	TCCTAGCTACGATTGGT	4992
15 Male-sterile AG <i>Brassica napus</i> Glu3Term GAA-TAA	CTCTCCCACTTCTTTTCGGTGGTTTATTCATTGGTGACGATATCA CAGAAGCAATGGATTAAAGGTGGGAGTAGTCACGATGCAGAGAGTA GCAAGAAGATAGGTAGAGGGAAGATAGAGA	4993
	TCTCTATCTTCCCTCTACCTATCTTCTGCTACTCTCTGCATCGTG ACTACTCCACCTTAATCCATTGCTTCTGTGATATCGTCACCAAAT GAATAAACCAACCGAAAAGAAGTGGGAGAG	4994
	CAATGGATTAAAGGTGGG	4995
	CCACCTTAATCCATTG	4996
20 Male-sterile AG <i>Brassica napus</i> Glu11Term GAG-TAG	TATTCATTGGTGACGATATCACAGAAGCAATGGATGAAGGTGGG AGTAGTCACGATGCATAGAGTAGCAAGAAGATAGGTAGAGGGAAG ATAGAGATAAAGAGGATAGAGAACACAACAA	4997
	TTGTTGTGTTCTCTATCCTCTTTATCTCTATCTTCCCTCTACCTATC TTCTTGCTACTCTATGCATCGTGACTACTCCACCTTCATCCATTG CTTCTGTGATATCGTCACCAAATGAATA	4998
	ACGATGCATAGAGTAGC	4999
	GCTACTCTATGCATCGT	5000
25 Male-sterile AG <i>Brassica napus</i> Lys14Term AAG-TAG	GGTGACGATATCACAGAAGCAATGGATGAAGGTGGGAGTAGTCA CGATGCAGAGAGTAGCTAGAAGATAGGTAGAGGGAAGATAGAGAT AAAGAGGATAGAGAACACAACAAATCGTCAAG	5001
	CTTGACGATTTGTTGTGTTCTCTATCCTCTTTATCTCTATCTTCCCT CTACCTATCTTCTAGCTACTCTCTGCATCGTGACTACTCCACCTT CATCCATTGCTTCTGTGATATCGTCACC	5002
	AGAGTAGCTAGAAGATA	5003
	TATCTTCTAGCTACTCT	5004

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Male-sterile AG <i>Brassica napus</i> Lys15Term AAG-TAG	GACGATATCACAGAAGCAATGGATGAAGGTGGGAGTAGTCACGAT GCAGAGAGTAGCAAGTAGATAGGTAGAGGGAAGATAGAGATAAAG AGGATAGAGAACACAACAAATCGTCAAGTAA	5005
	TTACTTGACGATTTGTTGTGTTCTCTATCCTCTTTATCTCTATCTTC CCTCTACCTATCTACTTGCTACTCTCTGCATCGTGACTACTCCCAC CTTCATCCATTGCTTCTGTGATATCGTC	5006
	GTAGCAAGTAGATAGGT	5007
	ACCTATCTACTTGCTAC	5008
10 Male-sterile AG <i>Lycopersicon esculentum</i> Glu4Term CAA-TAA	CAACCAAAAACTTAAAAATCTTCTCTTTCTTTCTTACAAGGTGA AGTAATGGACTTCTAAAGTGATCTAACCAGAGAGATCTCACCACAA AGGAACTAGGAAGGGGAAAATTGAGA	5009
	TCTCAATTTTCCCCCTTCTAGTTTCTTTGTGGTGAGATCTCTCT GGTTAGATCACTTTAGAAGTCCATTACTTCACCTTGTAAGGAAAGG AAAGAGAAGATTTTAAAGTTTTTGGTTG	5010
	TGGACTTCTAAAGTGAT	5011
	ATCACTTTAGAAGTCCA	5012
15 Male-sterile AG <i>Lycopersicon esculentum</i> Arg9Term AGA-TGA	AAAATCTTCTCTTTCTTTCTTACAAGGTGAAGTAATGGACTTCC AAAGTGATCTAACCAGAGATCTCACCACAAAGGAACTAGGAA GGGGGAAAATTGAGATCAAAAGGATCGAAA	5013
	TTTCGATCCTTTTGATCTCAATTTTCCCCCTTCTAGTTTCTTTGT GGTGAGATCTCTCAGGTTAGATCACTTTGGAAGTCCATTACTTCAC CTTGTAAGGAAAGGAAAGAGAAGATTTT	5014
	ATCTAACCTGAGAGATC	5015
	GATCTCTCAGGTTAGAT	5016
20 Male-sterile AG <i>Lycopersicon esculentum</i> Glu10Term GAG-TAG	ATCTTCTCTTTCTTTCTTACAAGGTGAAGTAATGGACTTCCAAA GTGATCTAACCAGATAGATCTCACCACAAAGGAACTAGGAAGGG GGAAAATTGAGATCAAAAGGATCGAAAACA	5017
	TGTTTTCGATCCTTTTGATCTCAATTTTCCCCCTTCTAGTTTCTT TGTGGTGAGATCTATCTGGTTAGATCACTTTGGAAGTCCATTACTT CACCTTGTAAGGAAAGGAAAGAGAAGAT	5018
	TAACCAGATAGATCTCA	5019
	TGAGATCTATCTGGTTA	5020
25 Male-sterile AG <i>Lycopersicon esculentum</i> Ser12Term TCA-TGA	CTTTCCTTTCTTACAAGGTGAAGTAATGGACTTCCAAAGTGATCT AACCAGAGAGATCTGACCACAAAGGAACTAGGAAGGGGAAAAT TGAGATCAAAAGGATCGAAAACACGACGAA	5021
	TTCGTCGTGTTTTGATCCTTTTGATCTCAATTTTCCCCCTTCTTA GTTTCCTTTGTGGTCAGATCTCTCTGGTTAGATCACTTTGGAAGTC CATTACTTCACCTTGTAAGGAAAGGAAAG	5022
	AGAGATCTGACCACAAA	5023

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TTTGTGGT <u>C</u> AGATCTCT	5024
5 Male-sterile NAG1 <i>Nicotiana tabacum</i> Gln4Term CAA-TAA	GTACTCTCTATTTTCATCTTCCAACCCCTTTCTTTCCTTACCAGGTGA AAGTATGGACTTCTAAAGTGATCTAACAAGAGAGATCTCTCCACAA AGGAACTGGGAAGAGGAAAGATTGAGA	5025
	TCTCAATCTTTCTCTTCCAGTTTCCTTTGTGGAGAGATCTCTCT TGTTAGATCACTTTA <u>G</u> AAGTCCATACTTTCACCTGGTAAGGAAAGA AAGGGTTGGAAGATGAAAATAGAGAGTAC	5026
	TGGACTTCTAAAGTGAT	5027
	ATCACTTTA <u>G</u> AAGTCCA	5028
	ATCTTCCAACCCCTTTCTTTCCTTACCAGGTGAAAGTATGGACTTCC AAAGTGATCTAACATGAGAGATCTCTCCACAAAGGAACTGGGAA GAGGAAAGATTGAGATCAAACGGATCGAAA	5029
10 Male-sterile NAG1 <i>Nicotiana tabacum</i> Arg9Term AGA-TGA	TTTCGATCCGTTTGATCTCAATCTTTCCTCTTCCAGTTTCCTTTGT GGAGAGATCTCTCA <u>T</u> GTTAGATCACTTTGGAAGTCCATACTTTCAC CTGGTAAGGAAAGAAAGGGTTGGAAGAT	5030
	ATCTAACATGAGAGATC	5031
	GATCTCTCA <u>T</u> GTTAGAT	5032
	TTCCAACCCCTTTCTTTCCTTACCAGGTGAAAGTATGGACTTCCAAA GTGATCTAACAAGATAGATCTCTCCACAAAGGAACTGGGAAGAG GAAAGATTGAGATCAAACGGATCGAAAACA	5033
15 Male-sterile NAG1 <i>Nicotiana tabacum</i> Glu10Term GAG-TAG	TGTTTTCGATCCGTTTGATCTCAATCTTTCCTCTTCCAGTTTCCTT TGTGGAGAGATCTA <u>T</u> CTTGTTAGATCACTTTGGAAGTCCATACTTT CACCTGGTAAGGAAAGAAAGGGTTGGA	5034
	TAACAAGATAGATCTCT	5035
	AGAGATCTA <u>T</u> CTTGTTA	5036
	CTTTCCTTACCAGGTGAAAGTATGGACTTCCAAAGTGATCTAACAA GAGAGATCTCTCCATAAAGGAACTGGGAAGAGGAAAGATTGAGA TCAAACGGATCGAAAACACAACGAATCGTC	5037
20 Male-sterile NAG1 <i>Nicotiana tabacum</i> Gln14Term CAA-TAA	GACGATTCGTTGTGTTTTCGATCCGTTTGATCTCAATCTTTCCTCT TCCAGTTTCCTTTA <u>T</u> GAGAGATCTCTCTTGTTAGATCACTTTGG AAGTCCATACTTTCACCTGGTAAGGAAAG	5038
	TCTCTCCATAAAGGAAA	5039
	TTTCCTTTA <u>T</u> GAGAGAGA	5040
	GCCTATGAAAACAAACCCAACACGGTCCTGGACGCTGATGCCCAA AGAAGATTGGGAAGGTGAAAGATCGAGATCAAGCGGATCGAAAAC ACCACCAATCGTCAAGTCACCTTCTGCAAAA	5041
25 Male-sterile AG <i>Rosa hybrida</i> Gly22Term GGA-TGA	TTTTGCAGAAGGTGACTTGACGATTGGTGGTGTTCGATCCGCT TGATCTCGATCTTTCACCTTCCCAATCTTCTTTGGGCATCAGCGTC CAGGACCGTGTTGGGTTTGTTCATAGGC	5042
	TGGGAAGGTGAAAGATC	5043
	GATCTTTCACCTTCCCA	5044

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Male-sterile AG <i>Rosa hybrida</i> Lys23Term AAG-TAG	TATGAAAACAAACCCAAACACGGTCCTGGACGCTGATGCCCAAAGA AGATTGGGAAGGGGATAGATCGAGATCAAGCGGATCGAAAACAC CACCAATCGTCAAGTCACCTTCTGCAAAAGGC	5045
	GCCTTTTGCAGAAGGTGACTTGACGATTGGTGGTGTTCGATCC GCTTGATCTCGATCTATCCCCTTCCCAATCTTCTTTGGGCATCAGC GTCCAGGACCGTGTTGGGTTTGTTCATA	5046
	GAAGGGGATAGATCGAG	5047
	CTCGATCTATCCCCTTC	5048
10 Male-sterile AG <i>Rosa hybrida</i> Glu25Term GAG-TAG	AACAAACCCAAACACGGTCCTGGACGCTGATGCCCAAAGAAGATTG GGAAGGGGAAAGATCTAGATCAAGCGGATCGAAAACACCACCAAT CGTCAAGTCACCTTCTGCAAAAGGCGCAATG	5049
	CATTGCGCTTTTGCAGAAGGTGACTTGACGATTGGTGGTGTTC CGATCCGCTTGATCTAGATCTTTCCCCTTCCCAATCTTCTTTGGGC ATCAGCGTCCAGGACCGTGTTGGGTTTGT	5050
	GAAAGATCTAGATCAAG	5051
	CTTGATCTAGATCTTTC	5052
15 Male-sterile AG <i>Rosa hybrida</i> Lys27 AAG-TAG	CCCAACACGGTCCTGGACGCTGATGCCCAAAGAAGATTGGGAAG GGGAAAGATCGAGATCTAGCGGATCGAAAACACCACCAATCGTCA AGTCACCTTCTGCAAAAGGCGCAATGGTTTGC	5053
	GCAAACCATTGCGCCTTTGCAGAAGGTGACTTGACGATTGGTGG TGTTTTCGATCCGCTAGATCTCGATCTTTCCCCTTCCCAATCTTCT TTGGGCATCAGCGTCCAGGACCGTGTTGGG	5054
	TCGAGATCTAGCGGATC	5055
	GATCCGCTAGATCTCGA	5056
20 Male-sterile far <i>Antirrhinum majus</i> Gln7Term CAA-TAA	CAATTGCCTGTTTTATTTTTTTCTTTTTGACTAAGTAGAAATGGC GTCTCTAAGCGATTAAATCGACCGAGGTATCGCCCGAGAGGAAAAT CGGGAGAGGAAAGATCGAGATCAAACGGA	5057
	TCCGTTTGATCTCGATCTTCTCCTCTCCCGATTTCTCCTCTCGGGCGA TACCTCGGTCGATTAAATCGCTTAGAGACGCCATTTCTACTTAGTCA AAAAGAAAAAAATAAAAACAGGCAATTG	5058
	TAAGCGATTAAATCGACC	5059
	GGTCGATTAAATCGCTTA	5060
25 Male-sterile far <i>Antirrhinum majus</i> Glu10Term GAG-TAG	GTTTTATTTTTTTCTTTTTGACTAAGTAGAAATGGCGTCTCTAAG CGATCAATCGACCTAGGTATCGCCCGAGAGGAAAATCGGGAGAG GAAAGATCGAGATCAAACGGATCGAAAACA	5061
	TGTTTTCGATCCGTTTGATCTCGATCTTCTCCTCTCCCGATTTCTCCT CTCGGGCGATACCTAGGTGCGATTGATCGCTTAGAGACGCCATTTCT TACTTAGTCAAAAAGAAAAAAATAAAAAC	5062
	AATCGACCTAGGTATCG	5063
	CGATACCTAGGTGCGATT	5064

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Male-sterile far <i>Antirrhinum majus</i> Glu14Term GAG-TAG	TTTCTTTTGGACTAAGTAGAAATGGCGTCTCTAAGCGATCAATCGA CCGAGGTATCGCCCTAGAGGAAAATCGGGAGAGGAAAGATCGAG ATCAAACGGATCGAAAACAAAACAAATCAAC	5065
	GTTGATTTGTTTTGTTTTCGATCCGTTTGATCTCGATCTTTCCTCTC CCGATTTTCCTCTAGGGCGATACCTCGGTGATTGATCGCTTAGA GACGCCATTTCTACTTAGTCAAAAAGAAA	5066
	TATCGCCCTAGAGGAAA	5067
	TTTCCTCTAGGGCGATA	5068
10 Male-sterile far <i>Antirrhinum majus</i> Lys16Term AAA-TAA	TTTGACTAAGTAGAAATGGCGTCTCTAAGCGATCAATCGACCGAG GTATCGCCCGAGAGGTAAATCGGGAGAGGAAAGATCGAGATCAA ACGGATCGAAAACAAAACAAATCAACAGGTTA	5069
	TAACCTGTTGATTTGTTTTGTTTTCGATCCGTTTGATCTCGATCTTT CCTCTCCCGATTTACCTCTCGGGCGATACCTCGGTGATTGATCG CTTAGAGACGCCATTTCTACTTAGTCAAA	5070
	CCGAGAGGTAAATCGGG	5071
	CCCGATTTACCTCTCGG	5072
15 Male-sterile AG <i>Cucumis sativus</i> Leu21Term TTG-TAG	TGTCCAAGCATTATCAGTCACCACTCACAAGAATGATTAAGGAAGA AGGAAAGGGTAAGTAGCAAATAAAGGGGATGTTCCAGAATCAAGA AGAGAAGATGTCAGACTCGCCTCAGAGGAA	5073
	TTCTCTGAGGCGAGTCTGACATCTTCTCTTCTTGATTCTGGAACA TCCCCTTTATTTGCTACTTACCCCTTCTTCTTCTTAATCATTCTT GTGAGTGGTGACTGATAATGCTTGGACA	5074
	GGTAAGTAGCAAATAA	5075
	TTATTTGCTACTTACCC	5076
20 Male-sterile AG <i>Cucumis sativus</i> Gln22Term CAA-TAA	TCCAAGCATTATCAGTCACCACTCACAAGAATGATTAAGGAAGAAG GAAAGGGTAAGTTGTAAATAAAGGGGATGTTCCAGAATCAAGAAG AGAAGATGTCAGACTCGCCTCAGAGGAAGA	5077
	TCTTCCTCTGAGGCGAGTCTGACATCTTCTCTTCTTGATTCTGGAA CATCCCCTTTATTTACAACCTACCCTTCTTCTTCTTAATCATTCT TTGTGAGTGGTGACTGATAATGCTTGGAA	5078
	GTAAGTTGTAAATAAAG	5079
	CTTTATTTACAACCTAC	5080
25 Male-sterile AG <i>Cucumis sativus</i> Lys24Term AAG-TAG	CATTATCAGTCACCACTCACAAGAATGATTAAGGAAGAAGGAAAG GGTAAGTTGCAATATAGGGGATGTTCCAGAATCAAGAAGAGAAG ATGTCAGACTCGCCTCAGAGGAAGATGGGAA	5081
	TTCCCATCTTCTCTGAGGCGAGTCTGACATCTTCTCTTCTTGATT CTGGAACATCCCCTATATTTGCAACTACCCTTCTTCTTCTTCTTA ATCATTCTTGTGAGTGGTGACTGATAATG	5082
	TGCAAAATATAGGGGATG	5083
	CATCCCCTATATTTGCA	5084

[illegible]

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Male-sterile AG <i>Zea mays</i> Arg4Term CGA-TGA	TCCTACCTTTTCTCCTTCAGACCTCAAATCTGTGTGATAGGAACA AGAGCATGCACATCTGAGAAGAGGAGGCTACACCATCCACAGTAA CAGGCATCATGTGACCCCTGACTTCGGCGG	5105
	CCGCCGAAGTCAGGGTCGACATGATGCCTGTTACTGTGGATGGT GTAGCCTCCTCTTCTCAGATGTGCATGCTCTTGTTCCTATCACACA GATTTTGAGGTCTGAAGGAGAAAAGGTAGGA	5106
	TGCACATCTGAGAAGAG	5107
	CTCTTCTCAGATGTGCA	5108
10 Male-sterile AG <i>Zea mays</i> Glu5Term GAA-TAA	TACCTTTTCTCCTTCAGACCTCAAATCTGTGTGATAGGAACAAGA GCATGCACATCCGATAAGAGGAGGCTACACCATCCACAGTAACAG GCATCATGTGACCCCTGACTTCGGCGGGGC	5109
	GCCCCGCCGAAGTCAGGGTCGACATGATGCCTGTTACTGTGGAT GGTGTAGCCTCCTCTTATCGGATGTGCATGCTCTTGTTCCTATCA CACAGATTTTGAGGTCTGAAGGAGAAAAGGTA	5110
	ACATCCGATAAGAGGAG	5111
	CTCCTCTTATCGGATGT	5112
15 Male-sterile AG <i>Zea mays</i> Glu6Term GAG-TAG	CTTTTCTCCTTCAGACCTCAAATCTGTGTGATAGGAACAAGAGCA TGCACATCCGAGAATAGGAGGCTACACCATCCACAGTAACAGGCA TCATGTGACCCCTGACTTCGGCGGGGCAGC	5113
	GCTGCCCGCCGAAGTCAGGGTCGACATGATGCCTGTTACTGTG GATGGTGTAGCCTCCTATTCTCGGATGTGCATGCTCTTGTTCCTA TCACACAGATTTTGAGGTCTGAAGGAGAAAAG	5114
	TCCGAGAATAGGAGGCT	5115
	AGCCTCCTATTCTCGGA	5116
20 Male-sterile AG <i>Zea mays</i> Glu7Term GAG-TAG	TTCTCCTTCAGACCTCAAATCTGTGTGATAGGAACAAGAGCATGC ACATCCGAGAAGAGTAGGCTACACCATCCACAGTAACAGGCATCA TGTCGACCCCTGACTTCGGCGGGGCAGCAGA	5117
	TCTGCTGCCCCGCCGAAGTCAGGGTCGACATGATGCCTGTTACT GTGGATGGTGTAGCCTACTCTTCTCGGATGTGCATGCTCTTGTTC CTATCACACAGATTTTGAGGTCTGAAGGAGAA	5118
	GAGAAGAGTAGGCTACA	5119
	TGTAGCCTACTCTTCTC	5120
25 Male-sterile AG <i>Oryza sativa</i> Lys5Term AAG-TAG	GCTGGGTGAGGATCGTCGGCGGCGGTGGCGGCGGGGAGCAGC GAGAAGATGGGGAGGGGGTAGATCGAGATAAAGCGGATCGAGAA CACGACGAACCGGCAGGTGACCTTCTGCAAGCGCC	5121
	GGCGCTTGAGAAGGTCACCTGCCGGTTCGTGCTGTTCTCGATC CGCTTTATCTCGATCTACCCCTCCCATCTTCTCGCTGCTCCCC GCCGCCACCGCCCGGACGATCCTGACCCAGC	5122
	GGAGGGGGTAGATCGAG	5123
	CTCGATCTACCCCTCC	5124

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Male-sterile AG <i>Oryza sativa</i> Glu7Term GAG-TAG	TCAGGATCGTCGGCGGCGGTGGCGGCGGGGAGCAGCGAGAAGA TGGGGAGGGGGAAGATCTAGATAAAGCGGATCGAGAACACGACG AACCGGCAGGTGACCTTCTGCAAGCGCCGCAATG	5125
	CATTGCGGCGCTTGAGAAGGTACCTGCCGGTTCGTGTTTC TCGATCCGCTTTATCTAGATCTTCCCCCTCCCCATCTTCTCGCTG CTCCCCGCCGCCACCGCCGCCGACGATCCTGA	5126
	GGAAGATCTAGATAAAG	5127
	CTTTATCTAGATCTTCC	5128
Male-sterile AG <i>Oryza sativa</i> Lys9Term AAG-TAG	TCGTCGGCGGCGGTGGCGGCGGGGAGCAGCGAGAAGATGGGG AGGGGGAAGATCGAGATATAGCGGATCGAGAACACGACGAACCG GCAGGTGACCTTCTGCAAGCGCCGCAATGGCCTCC	5129
	GGAGGCCATTGCGGCGCTTGAGAAGGTACCTGCCGGTTCGTC GTGTTCTCGATCCGCTATATCTCGATCTTCCCCCTCCCCATCTTCT CGCTGCTCCCCGCCGCCACCGCCGCCGACGA	5130
	TCGAGATATAGCGGATC	5131
	GATCCGCTATATCTCGA	5132
Male-sterile AG <i>Oryza sativa</i> Glu12Term GAG-TAG	GCGGTGGCGGCGGGGAGCAGCGAGAAGATGGGGAGGGGGAAG ATCGAGATAAAGCGGATCTAGAACACGACGAACCGGCAGGTGAC CTTCTGCAAGCGCCGCAATGGCCTCCTGAAGAAGG	5133
	CCTTCTTCAGGAGGCCATTGCGGCGCTTGAGAAGGTACCTGC CGGTTCTGTCGTGTTCTAGATCCGCTTTATCTCGATCTTCCCCCTC CCCATCTTCTCGTGCTCCCCGCCGCCACCGC	5134
	AGCGGATCTAGAACACG	5135
	CGTGTTCTAGATCCGCT	5136

Table 16
Oligonucleotides to produce male-sterile plants

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Male-sterile PI <i>Cucumis sativus</i> Tyr21Term TAT-TAG	GGGAAGAGGGAAAATAGAAATAAAAAGAATAGAGAACTCAAGCAAT AGACAAGTTACATAGTCAAAGAGAAGAAATGGTATCATCAAAAAG CCAAAGAAATTACTGTTCTTTGCGATGCT	5137
	AGCATCGCAAAGAACAGTAATTTCTTTGGCTTTTTTATGATGATACCAT TTCTTCTTTGACTATGTAACCTGTCTATTGCTTGAGTTCTCTATTG TTTTTATTTCTATTTTCCCTCTTCCC	5138

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GTTACATAGTCAAAGAG	5139
	CTCTTTGACTATGTAAC	5140
Male-sterile PI <i>Cucumis sativus</i> Ser22Term TCA-TGA	GAAGAGGGAAAATAGAAATAAAAAGAATAGAGAACTCAAGCAATAG ACAAGTTACATATTGAAAGAGAAGAAATGGTATCATCAAAAAGCC AAAGAAATTACTGTTCTTTGCGATGCTCA	5141
	TGAGCATCGCAAAGAACAGTAATTTCTTTGGCTTTTTGATGATACC ATTTCTTCTCTTTCAATATGTAAGTTGTCTATTGCTTGAGTTCTCTAT TCTTTTATTTCTATTTTCCCTCTTC	5142
	TACATATTGAAAGAGAA	5143
	TTCTCTTTCAATATGTA	5144
Male-sterile PI <i>Cucumis sativus</i> Lys23Term AAG-TAG	AGAGGGAAAATAGAAATAAAAAGAATAGAGAACTCAAGCAATAGAC AAGTTACATATTCATAGAGAAGAAATGGTATCATCAAAAAGCCAAA GAAATTACTGTTCTTTGCGATGCTCAAG	5145
	CTTGAGCATCGCAAAGAACAGTAATTTCTTTGGCTTTTTGATGATA CCATTTCTTCTCTATGAATATGTAAGTTGTCTATTGCTTGAGTTCTC TATTCTTTTATTTCTATTTTCCCTCT	5146
	CATATTCATAGAGAAGA	5147
	TCTTCTCTATGAATATG	5148
Male-sterile PI <i>Cucumis sativus</i> Arg24Term AGA-TGA	GGGAAAATAGAAATAAAAAGAATAGAGAACTCAAGCAATAGACAAG TTACATATTCAAAGTGAAGAAATGGTATCATCAAAAAGCCAAAGAA ATTACTGTTCTTTGCGATGCTCAAGTTT	5149
	AACTTGAGCATCGCAAAGAACAGTAATTTCTTTGGCTTTTTGATG ATACCATTTCTTCACTTTGAATATGTAAGTTGTCTATTGCTTGAGTT CTCTATTCTTTTATTTCTATTTTCCC	5150
	ATTCAAAGTGAAGAAAT	5151
	ATTTCTTCACTTTGAAT	5152
Male-sterile PI <i>Malus domestica</i> Tyr21Term TAC-TAG	GGGACGTGGGAAGGTTGAGATCAAGAGGATTGAGAACTCAAGTAA CAGGCAGGTGACCTAGTCCAAGAGGAGGAATGGGATTATCAAGAA GGCAAAGGAGATCACTGTTCTATGTGATGCT	5153
	AGCATCACATAGAACAGTGATCTCCTTTGCCTTCTTGATAATCCCA TTCTCCTCTTGGACTAGGTACCTGCCTGTTACTTGAGTTCTCAA TCCTCTTGATCTCAACCTTCCCACGTCCC	5154
	GTGACCTAGTCCAAGAG	5155
	CTCTTGGACTAGGTCAC	5156

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Male-sterile PI <i>Malus domestica</i> Lys23Term. AAG-TAG	CGTGGGAAGGTTGAGATCAAGAGGATTGAGAACTCAAGTAACAGG CAGGTGACCTACTCCTAGAGGAGGAATGGGATTATCAAGAAGGCA AAGGAGATCACTGTTCTATGTGATGCTAAAG	5157
	CTTTAGCATCACATAGAACAGTGATCTCCTTTGCCTTCTTGATAATC CCATTCCCTCCTCTAGGAGTAGGTCACCTGCCTGTTACTTGAGTTCT CAATCCTCTTGATCTCAACCTTCCCACG	5158
	CCTACTCCTAGAGGAGG	5159
	CCTCCTCTAGGAGTAGG	5160
10 Male-sterile PI <i>Malus domestica</i> Lys30Term AAG-TAG	AGGATTGAGAACTCAAGTAACAGGCAGGTGACCTACTCCAAGAGG AGGAATGGGATTATCTAGAAGGCAAAGGAGATCACTGTTCTATGTG ATGCTAAAGTATCTCTTATCATTTATTCTA	5161
	TAGAATAAATGATAAGAGATACTTTAGCATCACATAGAACAGTGATC TCCTTTGCCTTCTAGATAATCCCATTCCTCCTCTTGGAGTAGGTCA CCTGCCTGTTACTTGAGTTCTCAATCCT	5162
	GGATTATCTAGAAGGCA	5163
	TGCCTTCTAGATAATCC	5164
15 Male-sterile PI <i>Malus domestica</i> Lys31Term AAG-TAG	ATTGAGAACTCAAGTAACAGGCAGGTGACCTACTCCAAGAGGAGG AATGGGATTATCAAGTAGGCAAAGGAGATCACTGTTCTATGTGATG CTAAAGTATCTCTTATCATTTATTCTAGCT	5165
	AGCTAGAATAAATGATAAGAGATACTTTAGCATCACATAGAACAGT GATCTCCTTTGCCTACTTGATAATCCCATTCCTCCTCTTGGAGTAG GTCACCTGCCTGTTACTTGAGTTCTCAAT	5166
	TTATCAAGTAGGCAAAG	5167
	CTTTGCCTACTTGATAA	5168
20 Male-sterile globosa <i>Antirrhinum majus</i> Gly2Term GGA-TGA	CATTTTTACAATAGTTATCTGCAAAACAAAAACAAGAGAGAAAAACAA AAACAAAAAATGTGAAGAGGAAAAATTGAGATCAAAGAATTGAG AACTCAAGCAACAGGCAGGTTACTTACT	5169
	AGTAAGTAACCTGCCTGTTGCTTGAGTTCTCAATTCTTTTGATCTCA ATTTTTCTCTTCAATTTTTTTGTTTTGTTTTCTCTCTTGTTTTG TTTGCAGATAACTATTGTA AAAATG	5170
	AAAAAATGTGAAGAGGA	5171
	TCCTCTTCAATTTTTT	5172
25 Male-sterile globosa <i>Antirrhinum majus</i> Arg3Term AGA-TGA	TTTTACAATAGTTATCTGCAAAACAAAAACAAGAGAGAAAAACAAAA CAAAAAAATGGGATGAGGAAAAATTGAGATCAAAGAATTGAGAAC TCAAGCAACAGGCAGGTTACTTACTCAA	5173
	TTGAGTAAGTAACCTGCCTGTTGCTTGAGTTCTCAATTCTTTGATC TCAATTTTTCTCATCCCATTTTTTTGTTTTGTTTTCTCTCTTGT TTTGTITGCAGATAACTATTGTA AAA	5174

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	AAATGGGATGAGGAAAA	5175
	TTTTCTCATCCCATT	5176
Male-sterile globosa <i>Antirrhinum majus</i> Gly4Term GGA-TGA	TACAATAGTTATCTGCAAAACAAAAACAAGAGAGAAAAACAAAAACAA AAAAATGGGAAGATGAAAAATTGAGATCAAAGAATTGAGAACTCA AGCAACAGGCAGGTTACTTACTCAAAGA	5177
	TCTTTGAGTAAGTAACCTGCCTGTTGCTTGAGTTCTCAATTCTTTG ATCTCAATTTTTCATCTTCCCATTTTTTGTTTTGTTTTCTCTCTT GTTTTGTTTGCAGATAACTATTGA	5178
	TGGGAAGATGAAAAATT	5179
	AATTTTTCATCTTCCA	5180
Male-sterile globosa <i>Antirrhinum majus</i> Lys5Term AAA-TAA	AATAGTTATCTGCAAAACAAAAACAAGAGAGAAAAACAAAAACAAAA AATGGGAAGAGGATAAATTGAGATCAAAGAATTGAGAACTCAAGC AACAGGCAGGTTACTTACTCAAAGAGAA	5181
	TTCTCTTTGAGTAAGTAACCTGCCTGTTGCTTGAGTTCTCAATTCTT TTGATCTCAATTTATCCTCTTCCCATTTTTTGTTTTGTTTTCTCT CTTGTTTTGTTTGCAGATAACTATT	5182
	GAAGAGGATAAATTGAG	5183
	CTCAATTTATCCTCTTC	5184
Male-sterile PI <i>Zea mays</i> Lys5Term AAG-TAG	GCTGAGCTCTTGCTGCCCTTGGATCTGTTGGGAGTGGAGAACGC AGTATGGGGCGCGGCTAGATCAAGATCAAGAGGATCGAGAACTCT ACCAACCGGCAGGTGACCTTCTCCAAGCGCC	5185
	GGCGCTTGGAGAAGGTCACCTGCCGTTGGTAGAGTTCTCGATCC TCTTGATCTTGATCTAGCCGCGCCCCATACTGCGTTCTCCACTCC CAAACAGATCCAAGGGCAGCAAGAGCTCAGC	5186
	GGCGCGGCTAGATCAAG	5187
	CTTGATCTAGCCGCGCC	5188
Male-sterile PI <i>Zea mays</i> Lys7Term AAG-TAG	CTCTTGCTGCCCTTGGATCTGTTGGGAGTGGAGAACGCAGTATG GGGCGCGGCAAGATCTAGATCAAGAGGATCGAGAACTCTACCAAC CGGCAGGTGACCTTCTCCAAGCGCCGGGCCG	5189
	CGGCCCGCGCTTGGAGAAGGTCACCTGCCGTTGGTAGAGTTC TCGATCCTCTTGATCTAGATCTTGCCGCGCCCCATACTGCGTTCTC CACTCCCAAACAGATCCAAGGGCAGCAAGAG	5190
	GCAAGATCTAGATCAAG	5191
	CTTGATCTAGATCTTGC	5192

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Male-sterile PI <i>Zea mays</i> Lys9Term AAG-TAG	CTCTTGCTGCCCTTGGATCTGTTTGGGAGTGGAGAACGCAGTATG GGGCGCGGCAAGATCTAGATCAAGAGGATCGAGAACTCTACCAAC CGGCAGGTGACCTTCTCCAAGCGCCGGGCCG	5193
	CGGCCCCGGCGCTTGGAGAAGGTCACCTGCCGGTTGGTAGAGTTC TCGATCCTCTTGATCTAGATCTTGCCGCGCCCCATACTGCGTTCTC CACTCCCAAACAGATCCAAGGGCAGCAAGAG	5194
	GCAAGATCTAGATCAAG	5195
	CTTGATCTAGATCTTGC	5196
10 Male-sterile PI <i>Zea mays</i> Glu12Term GAG-TAG	GATCTGTTTGGGAGTGGAGAACGCAGTATGGGGCGCGGCAAGAT CAAGATCAAGAGGATCTAGA ACTCTACCAACCGGCAGGTGACCTT CTCCAAGCGCCGGGCCGGA CTGGTCAAGAAGG	5197
	CCTTCTTGACCAGTCCGGCCCGCGCTTGGAGAAGGTCACCTGC CGGTTGGTAGAGTTCTAGATCCTCTTGATCTTGATCTTGCCGCGC CCCATACTGCGTTCTCCACTCCCAAACAGATC	5198
	AGAGGATCTAGA ACTCT	5199
	AGAGTTCTAGATCCTCT	5200
15 Male-sterile PI <i>Zea mays</i> Lys5Term AAG-TAG	GCTGAGCTCTTGCTGCCCTTGAATCTGTTAGGGAGTGGAGAACGG AGTATGGGGCGCGGCTAGATCGAGATCAAGAGGATCGAGAACTCT ACCAACCGGCAGGTGACCTTCTCCAAGCGCC	5201
	GGCGCTTGGAGAAGGTCACCTGCCGGTTGGTAGAGTTCTCGATCC TCTTGATCTCGATCTAGCCGCGCCCCATACTCCGTTCTCCACTCC CTAACAGATTCAAGGGCAGCAAGAGCTCAGC	5202
	GGCGCGGCTAGATCGAG	5203
	CTCGATCTAGCCGCGCC	5204
20 Male-sterile PI <i>Zea mays</i> Glu7Term GAG-TAG	CTCTTGCTGCCCTTGAATCTGTTAGGGAGTGGAGAACGGAGTATG GGGCGCGGCAAGATCTAGATCAAGAGGATCGAGAACTCTACCAAC CGGCAGGTGACCTTCTCCAAGCGCCGGGCCG	5205
	CGGCCCCGGCGCTTGGAGAAGGTCACCTGCCGGTTGGTAGAGTTC TCGATCCTCTTGATCTAGATCTTGCCGCGCCCCATACTCCGTTCTC CACTCCCTAACAGATTCAAGGGCAGCAAGAG	5206
	GCAAGATCTAGATCAAG	5207
	CTTGATCTAGATCTTGC	5208
25 Male-sterile PI <i>Zea mays</i> Lys9Term AAG-TAG	CTGCCCTTGAATCTGTTAGGGAGTGGAGAACGGAGTATGGGGCG CGGCAAGATCGAGATCTAGAGGATCGAGAACTCTACCAACCGGCA GGTGACCTTCTCCAAGCGCCGGGCCGGA CTGG	5209
	CCAGTCCGGCCCCGGCGCTTGGAGAAGGTCACCTGCCGGTTGGTA GAGTTCTCGATCCTCTAGATCTCGATCTTGCCGCGCCCCATACTC CGTTCTCCACTCCCTAACAGATTCAAGGGCAG	5210

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	TCGAGATCTAGAGGATC	5211
	GATCCTCTAGATCTCGA	5212
	AATCTGTTAGGGAGTGGAGAACGGAGTATGGGGCGCGGCAAGAT CGAGATCAAGAGGATCTAGA ACTCTACCAACCGGCAGGTGACCTT CTCCAAGCGCCGGGCCGGA CTGGTCAAGAAGG	5213
	CCTTCTTGACCAAGTCCGGCCCGGCGCTTGGAGAAGGTACCTGC CGGTTGGTAGAGTTCTAGATCCTCTTGATCTCGATCTTGCCGCGC CCCATACTCCGTTCTCCACTCCCTAACAGATT	5214
	AGAGGATCTAGA ACTCT	5215
	AGAGTTCTAGATCCTCT	5216
10	TTGCTGCTAAGCTAGCTGGAGGAAGGAGGAGGAGGAGGAGGAGG CGGGATGGGGCGCGGGTAGATCGAGATCAAGAGGATCGAGAACT CCACCAACCGCCAGGTGACCTTCTCCAAGCGCA	5217
	TGCGCTTGGAGAAGGTACCTGGCGGTTGGTGGAGTTCTCGATCC TCTTGATCTCGATCTACCCGCGCCCCATCCGCGCTCCTCCTCCTC CTCCTCCTCCTCCAGCTAGCTTAGCAGCAA	5218
	GGCGCGGGTAGATCGAG	5219
	CTCGATCTACCCGCGCC	5220
15	CTAAGCTAGCTGGAGGAAGGAGGAGGAGGAGGAGGAGGAGGCGGGA TGGGGCGCGGGAAGATCTAGATCAAGAGGATCGAGAACTCCACC AACCGCCAGGTGACCTTCTCCAAGCGCAGGAGCG	5221
	CGCTCCTGCGCTTGGAGAAGGTACCTGGCGGTTGGTGGAGTTC TCGATCCTCTTGATCTAGATCTTCCGCGCCCCATCCGCGCTCCT CCTCCTCCTCCTCCTCCTCCAGCTAGCTTAG	5222
	GGAAGATCTAGATCAAG	5223
	CTTGATCTAGATCTTCC	5224
20	TAGCTGGAGGAAGGAGGAGGAGGAGGAGGAGGAGGCGGGATGGGGC GCGGGAAGATCGAGATCTAGAGGATCGAGAACTCCACCAACCGC CAGGTGACCTTCTCCAAGCGCAGGAGCGGGATCC	5225
	GGATCCCGCTCCTGCGCTTGGAGAAGGTACCTGGCGGTTGGTG GAGTTCTCGATCCTCTAGATCTCGATCTTCCGCGCCCCATCCCG CCTCCTCCTCCTCCTCCTCCTCCTCCTCCAGCTA	5226
	TCGAGATCTAGAGGATC	5227
	GATCCTCTAGATCTCGA	5228

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Male-sterile PI <i>Oryza sativa</i> Glu12Term GAG-TAG	GAAGGAGGAGGAGGAGGAGGAGGCGGGATGGGGCGCGGGAAGA TCGAGATCAAGAGGATCTAGAACTCCACCAACCGCCAGGTGACCT TCTCCAAGCGCAGGAGCGGGATCCTCAAGAAGG	5229
	CCTTCTTGAGGATCCCGCTCCTGCGCTTGGAGAAGGTCACCTGGC GGTTGGTGGAGTTCTAGATCCTCTTGATCTCGATCTTCCCGCGCC CCATCCCGCCTCCTCCTCCTCCTCCTCCTC	5230
	AGAGGATCTAGAACTCC	5231
	GGAGTTCTAGATCCTCT	5232

Example 7**Engineering plants for abiotic stress tolerance**

Environmental stresses, such as drought, increased soil salinity, soil contamination with heavy metals, and extreme temperature, are major factors limiting plant growth and productivity. The worldwide loss in yield of three major cereal crops, rice, maize, and wheat due to water stress (drought) has been estimated to be over ten billion dollars annually and many currently marginal soils could be brought into cultivation if suitable plant varieties were available.

Physiological and biochemical responses to high levels of ionic or nonionic solutes and decreased water potential have been studied in a variety of plants. It is known, for example, that increasing levels of alcohol dehydrogenase can confer enhanced flooding resistance in plants. There are also several possible mechanisms to enhance plant salt tolerance. For example, one mechanism underlying the adaptation or tolerance of plants to osmotic stresses is the accumulation of compatible, low molecular weight osmolytes such as sugar alcohols, special amino acids, and glycinebetaine. Such accumulation can be engineered, for example, by removing feedback inhibition on 1-pyrroline-t-carboxylate synthetase, which results in accumulation of proline. Additionally, recent experiments suggest that altering the expression or activity of specific sodium or potassium transporters can confer enhanced salt tolerance.

Plant tolerance of contamination by heavy metals such as lead and aluminum in soils has also been investigated and one mechanism underlying tolerance is the production of dicarboxylic acids such as oxalate and citrate. In addition, individual genes involved in heavy metal sensitivity have been identified.

The attached tables disclose exemplary oligonucleotide base sequences which can be used to generate site-specific mutations that confer stress tolerance in plants.

Table 17
Genome-Altering Oligos Conferring Stress Tolerance

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Salt Tolerance P5CS <i>Arabidopsis thaliana</i> Phe128Ala TTT-GCT	CGTCTTTTTGTGTGGTAGTTGGATGTGACGGTTGCTCAAATGCTT GTGACCGATAGCAGT <u>G</u> CTAGAGATAAGGATTTTCAGGAAGCAACTT AGTGAAACTGTCAAAGCGATGCTGAGGATGA	5233
	TCATCCTCAGCATCGCTTTGACAGTTTCACTAAGTTGCTTCCTGAA ATCCTTATCTCTAG <u>C</u> ACTGCTATCGGTCACAAGCATTTGAGCAACC GTCACATCCAACTACCACACAAAAAGACG	5234
	ATAGCAGT <u>G</u> CTAGAGAT	5235
	ATCTCTAG <u>C</u> ACTGCTAT	5236
Salt Tolerance P5CS 1 <i>Brassica napus</i> Phe128Ala TTC-GCC	GAGACTATGTTTGACCAGCTGGATGTGACGGCTGCTCAGCTGCTG GTGAATGACAGTAGT <u>G</u> CCAGAGACAAGGAGTTTCAGGAAGCAACTT AATGAGACAGTGAAGTCCATGCTTGATTGA	5237
	TCAAATCAAGCATGGACTTCACTGTCTCATTAAAGTTGCTTCCTGAA CTCCTTGTCTCTG <u>G</u> CACTACTGTCAATCACCAGCAGCTGAGCAGC CGTCACATCCAGCTGGTCAAACATAGTCTC	5238
	ACAGTAGT <u>G</u> CCAGAGAC	5239
	GTCTCTG <u>G</u> CACTACTGT	5240
Salt Tolerance P5CS 2 <i>Brassica napus</i> Phe129Ala TTC-GCC	GAGACTATGTTTGACCAGATGGATGTGACGGTGGCTCAAATGCTG GTGACTGATAGCAGT <u>G</u> TCAGAGATAAGGATTTTCAGGAAGCAACTT AGTGAGACAGTCAAAGCTATGCTGAAAATGA	5241
	TCATTTTCAGCATAGCTTTGACTGTCTCACTAAGTTGCTTCCTGAA ATCCTTATCTCTG <u>A</u> CACTGCTATCAGTCACCAGCATTTGAGCCACC GTCACATCCATCTGGTCAAACATAGTCTC	5242
	ATAGCAGT <u>G</u> TCAGAGAT	5243
	ATCTCTG <u>A</u> CACTGCTAT	5244
Salt Tolerance P5CS <i>Oryza sativa</i> Phe128Ala TTT-GCT	GATATGTTGTTTAACCAACTGGATGTCTCGTCATCTCAACTTCTTG TCACCGACAGTGAT <u>G</u> CTGAGAACCCAAAGTTCCGGGAGCAACTCA CTGAAACTGTTGAGTCATTATTAGATCTTA	5245
	TAAGATCTAATAATGACTCAACAGTTTCAGTGAGTTGCTCCCGGAA CTTTGGGTTCTCAG <u>C</u> ATCACTGTCCGGTGACAAGAAGTTGAGATGA CGAGACATCCAGTTGGTTAAACAACATATC	5246
	ACAGTGAT <u>G</u> CTGAGAAC	5247
	GTTCTCAG <u>C</u> ATCACTGT	5248

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Salt Tolerance P5CS <i>Medicago sativa</i> Phe128Ala TTT-GCT	GATATTTTGTAGTCAGCTGGATGTGACATCTGCTCAGCTTCTTG TTACTGACAATGATGCTAGAGACCAAGATTTAGAAAGCAACTTTC TGAAACTGTGAGATCACTTCTAGCACTAA	5249
	TTAGTGCTAGAAGTGATCTCACAGTTTCAGAAAGTTGCTTTCTAAA ATCTTGGTCTCTAGCATCATTGTCAGTAACAAGAAGCTGAGCAGAT GTCACATCCAGCTGACTAAACAAAATATC	5250
	ACAATGATGCTAGAGAC	5251
	GTCTCTAGCATCATTGT	5252
10 Salt Tolerance P5CS <i>Actinidia deliciosa</i> Phe128Ala TTT-GCT	GATACATTGTTAGTCAGCTGGATGTGACATCAGCTCAGCTACTC GTTACTGATAATGATGCTAGGGATCCAGAATTCAGGAAGCAACTTA CTGAAACTGTAGAATCACTATTGAATTTGA	5253
	TCAAATTC AATAGTGATTCTACAGTTTCAGTAAGTTGCTTCCTGAAT TCTGGATCCCTAGCATCATTATCAGTAACGAGTAGCTGAGCTGAT GTCACATCCAGCTGACTAAACAATGTATC	5254
	ATAATGATGCTAGGGAT	5255
	ATCCCTAGCATCATTAT	5256
15 Salt Tolerance P5CS <i>Cichorium intybus</i> Phe122Ala TTC-GCC	GACACACTCTTCAGTCAACTGGATGTGACATCAGCACAGCTTCTT GTAACAGATAATGACGCCAGAAAGTCCAGAATTTAGAAAACAACCTTA CTGAAACAGTCGATTCTTTATTATCTTATA	5257
	TATAAGATAATAAAGAATCGACTGTTTCAGTAAGTTGTTTTCTAAAT TCTGGACTTCTGGCGTCATTATCTGTTACAAGAAGCTGTGCTGAT GTCACATCCAGTTGACTGAAGAGTGTGTC	5258
	ATAATGACGCCAGAAAGT	5259
	ACTTCTGGCGTCATTAT	5260
20 Salt Tolerance P5CS <i>Lycopersicon esculentum</i> Phe128Ala TTT-GCT	GATTCTTTGTTTCAGTCAGTTGGATGTGACATCAGCTCAGCTTCTGG TGACTGATAATGACGCTAGAGATCCAGATTTTAGGAGACAACCTCAA TGACACAGTAAATTCGTTGCTTTCTCTAA	5261
	TTAGAGAAAGCAACGAATTTACTGTGTCATTGAGTTGTCTCCTAAA ATCTGGATCTCTAGCGTCATTATCAGTCACCAGAAGCTGAGCTGA TGTCACATCCAAGTACTGAACAAAGAATC	5262
	ATAATGACGCTAGAGAT	5263
	ATCTCTAGCGTCATTAT	5264
25 Salt Tolerance P5CS <i>Vigna unguiculata</i> Phe162Ala TTT-GCT	GATACCATGTTTCAGCCAGCTTGATGTGACTTCTTCCCAACTTCTTG TGAATGATGGATTTGCTAGGGATGCTGGCTTCAGAAAACAACCTTTC GGACACAGTGAACGCGTTATTAGATTTAA	5265
	TTAAATCTAATAACGCGTTCACTGTGTCCGAAAGTTGTTTTCTGAA GCCAGCATCCCTAGCAAATCCATCATTACAAGAAGTTGGGAAGA AGTCACATCAAGCTGGCTGAACATGGTATC	5266
	ATGGATTTGCTAGGGAT	5267

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	ATCCCTAGCAAATCCAT	5268
5 Salt Tolerance P5CS <i>Mesembryanthemum crystallinum</i> Phe125Ala TTT-GCT	GACACCTTGTITAGTCAGTTGGATCTGACTGCTGCTCAGCTGCTT GTGACGGACAACGACGCTAGAGATCCAAGTTTTAGAACACAACCTA ACTGAAACAGTGTATCAGTTGTTGGATCTAA	5269
	TTAGATCCAACAACCTGATACACTGTTTCAGTTAGTTGTGTTCTAAAA CTTGGATCTCTAGCGTCGTTGTCCGTCACAAGCAGCTGAGCAGCA GTCAGATCCAACCTGACTAAACAAGGTGTC	5270
	ACAACGACGCTAGAGAT	5271
	ATCTCTAGCGTCGTTGT	5272
10 Salt Tolerance P5CS <i>Vitis vinifera</i> Phe130Ala TTT-GCT	GACACATTATTTAGCCAGCTGGATGTGACATCAGCTCAGCTTCTT GTGACTGATAATGATGCTAGGGATGAAGCTTTCCGAAATCAACTTA CTCAAACAGTGGATTCATTGTTAGCTTTGA	5273
	TCAAAGCTAACAATGAATCCACTGTTTGAGTAAGTTGATTTCCGAA AGCTTCATCCCTAGCATCATTATCAGTCACAAGAAGCTGAGCTGAT GTCACATCCAGCTGGCTAAATAATGTGTC	5274
	ATAATGATGCTAGGGAT	5275
	ATCCCTAGCATCATTAT	5276
15 Salt Tolerance P5CS <i>Vigna aconitifolia</i> Phe129Ala TTT-GCT	GATACGCTGTTCACTCAGCTCGATGTGACATCGGCTCAGCTTCTT GTGACGGATAACGATGCTCGAGATAAGGATTTGAGGAAGCAGCTT ACTGAGACTGTGAAGTCGCTGTTGGCGCTGA	5277
	TCAGCGCCAACAGCGACTTCACAGTCTCAGTAAGCTGCTTCCTGA AATCCTTATCTCGAGCATCGTTATCCGTCACAAGAAGCTGAGCCG ATGTCACATCGAGCTGAGTGAACAGCGTATC	5278
	ATAACGATGCTCGAGAT	5279
	ATCTCGAGCATCGTTAT	5280
20 Salt Tolerance HKT1 <i>Arabidopsis thaliana</i> Ser207Val TCC-GTC	AGAGATGTTCTTAGTTCCAAAGAAATCTCACCTCTCACTTTCTCCG TCTTCACAACAGTTGTCACGTTTGCAAACCTGCGGATTTGTCCCCAC GAATGAGAACATGATCATCTTTGCAAAA	5281
	TTTTGCGAAAGATGATCATGTTCTCATTGTTGGGGACAAATCCGCA GTTTGCAAACGTGACAACTGTTGTGAAGACGGAGAAAGTGAGAGG TGAGATTTCTTTGGAACATAAGAACATCTCT	5282
	CAACAGTTGTCACGTTT	5283
	AAACGTGACAACTGTTG	5284
25 Salt Tolerance HKT1 <i>Arabidopsis thaliana</i> Gln237Leu CAA-CTA	CGAATGAGAACATGATCATCTTTGCAAAAACCTCTGGTCTCATCTG GCTCCTAATCCCTCTAGTACTGATGGGAAACACTTTGTTCCCTTGC TTCTTGGTTTTGCTCATATGGGGACTTTA	5285
	TAAAGTCCCCATATGAGCAAAACCAAGAAGCAAGGGAACAAAGTG TTTCCCATCAGTACTAGAGGGATTAGGAGCCAGATGAGACCAGAG TTTTTGCAGAAAGATGATCATGTTCTCATTG	5286

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	AATCCCTC <u>T</u> AGTACTGA	5287
	TCAGTACT <u>A</u> GAGGGATT	5288
	Salt Tolerance HKT1 <i>Arabidopsis thaliana</i> Asn332Ser AAT-AGT	5289
	AGTCTCTAGAAGGAATGAGTTCGTACGAGAAGTTGGTTGGATCGT TGTTTCAAGTGGTGAGTTCGCGACACACCGGAGAACTATAGTAG ACCTCTCTACACTTTCCCCAGCTATCTTGGT	5290
10	ACCAAGATAGCTGGGGAAAGTGTAGAGAGGTCTACTATAGTTTCT CCGGTGTGTGCGGA <u>A</u> CTCACCACCTTGAAACAACGATCCAACCAAC TTCTCGTACGAACCTATTCCTTCTAGAGACT	5291
	AGTGGTGAGTTCGCGAC	5292
	GTCGCGAACTCACCACCT	5293
	Salt Tolerance HKT1 <i>Eucalyptus camaldulensis</i> Ser256Val TCG-GTG	5294
15	AGAGATGTGCTAAAGAAGAAAGGTCTCAAATGGTGACCTTTTCC GTCTTCACCACCGTG <u>G</u> TGACCTTTGCCAGTTGTGGGTTTGTCCCG ACCAATGAAAACATGATTATCTTCAGCAAAA	5295
	TTTTGCTGAAGATAATCATGTTTTATTGGTCGGGACAAACCCACA ACTGGCAAAGGTC <u>A</u> CCACGGTGGTGAAGACGGAAAGGTCACCA TTTTGAGACCTTTCTTCTTTAGCACATCTCT	5296
	CCACCGTG <u>G</u> TGACCTTT	5297
	AAAGGTCA <u>C</u> ACCGGTGG	5298
20	Salt Tolerance HKT1 <i>Eucalyptus camaldulensis</i> Gln286Leu CAG-CTG	5299
	CCAATGAAAACATGATTATCTTCAGCAAAAACTCTGGCCTCCTCCT GATTCTCATCCCTC <u>T</u> GGCCCTTCTTGGGAACATGCTGTTCCCATC GAGCCTACGTTTGACGCTTTGGCTCATCGG	5300
	CCGATGAGCCAAAGCGTCAAACGTAGGCTCGATGGGAACAGCAT GTTCCCAAGAAGGGCC <u>A</u> GAGGGATGAGAATCAGGAGGAGGCCA GAGTTTTTGCTGAAGATAATCATGTTTTATTGG	5301
	CATCCCTC <u>T</u> GGCCCTTC	5302
25	GAAGGGCC <u>A</u> GAGGGATG	5303
	Salt Tolerance HKT1 <i>Eucalyptus camaldulensis</i> Asn381Ser AAC-AGC	5304
	AATCGTTGAATGGACTAAGCTCCTGTGAGAAAATCGTGGGCGCGC TGTTTCAGTGCGTGAGCAGCAGACATACCGGCGAGACGGTCGTC GATCTGTCCACAGTTGCTCCCGCCATCTTGGT	5305
	ACCAAGATGGCGGGAGCAACTGTGGACAGATCGACGACCGTCTC GCCGGTATGTCTGCTG <u>C</u> TACGCACTGAAACAGCGCGCCACGA TTTTCTCACAGGAGCTTAGTCCATTCAACGATT	5306
30	GTGCGTGAGCAGCAGAC	5307
	GTCTGCTG <u>C</u> TACGCAC	5308

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Salt Tolerance HKT1 <i>Oryza sativa</i> Ser238Val TCC-GTC	AAAGCTCCACTGAAGAAGAAAGGGATCAACATTGCACTCTTCTCAT TCTCGGTCACGGTCTCTCGTTTGCGAATGTGGGGCTCGTGCCG ACAAATGAGAACATGGCAATCTTCTCCAAGA	5305
	TCTTGGAGAAGATTGCCATGTTCTCATTTGTCGGCACGAGCCCCA CATTGCGAAACGAGACGACCGTGACCGAGAATGAGAAGAGTGCA ATGTTGATCCCTTTCTTCTTCAGTGGAGCTTT	5306
	TCACGGTCTCTCGTTT	5307
	AAACGAGACGACCGTGA	5308
10 Salt Tolerance HKT1 <i>Oryza sativa</i> Gln268Leu CAG-CTG	CAAATGAGAACATGGCAATCTTCTCCAAGAACCCGGGCCTCCTCC TCCTGTTTCATCGGCCCTGATTCTTGCAAGCAATACACTTTACCTCT CTTCCTAAGGCTATTGATATGGTTCTCTGGG	5309
	CCCAGGAACCATATCAATAGCCTTAGGAAGAGAGGGTAAAGTGTA TTGCCTGCAAGAATCAGGCCGATGAACAGGAGGAGGAGGCCCGG GTTCTTGGAGAAGATTGCCATGTTCTCATTTG	5310
	CATCGGCCCTGATTCTTG	5311
	CAAGAATCAGGCCGATG	5312
15 Salt Tolerance HKT1 <i>Oryza sativa</i> Asn363Ser AAC-AGC	CAGTCTTTGATGGACTCAGCTCTTACCAGAAGATTATCAATGCATT GTTTCATGGCAGTGAGCGCAAGGCACTCGGGGGAGAACTCCATCG ACTGCTCACTCATCGCCCCTGCTGTTCTAGT	5313
	ACTAGAACAGCAGGGGCGATGAGTGAGCAGTCGATGGAGTTCTC CCCCGAGTGCCTTGCGCTCACTGCCATGAACAATGCATTGATAAT CTTCTGGTAAGAGCTGAGTCCATCAAAGACTG	5314
	GGCAGTGAGCGCAAGGC	5315
	GCCTTGCGCTCACTGCC	5316
20 Salt Tolerance HKT1 <i>Triticum aestivum</i> Ala240Val GCC-GTC	GTGCCCCACTGAACAAGAAAGGGATCAACATCGTGCTCTTCTCAC TATCAGTCACCGTTGTCTCCTGTGCGAATGCAGGACTCGTGCCCA CAAATGAGAACATGGTCATCTTCTCAAAGAA	5317
	TTCTTTGAGAAGATGACCATGTTCTCATTTGTGGGCACGAGTCCT GCATTGCGACAGGAGACAACGGTGACTGATAGTGAGAAGAGCAC GATGTTGATCCCTTTCTTGTTTCAGTGGGGCAC	5318
	CACCGTTGTCTCCTGTG	5319
	CACAGGAGACAACGGTG	5320
25 Salt Tolerance HKT1 <i>Triticum aestivum</i> Gln270Leu CAG-CTG	CAAATGAGAACATGGTCATCTTCTCAAAGAATTCAGGCCTCTTGTT GCTGCTGAGTGGCCCTGATGCTCGCAGGCAATACATTGTTCCCTCT CTTCCTGAGGCTACTGGTGTGGTTCTCTGGG	5321
	CCCAGGAACCACACCACTAGCCTCAGGAAGAGAGGGAACAATGT ATTGCCTGCGAGCATCAGGCCACTCAGCAGCAACAAGAGGCCTG AATCTTTGAGAAGATGACCATGTTCTCATTTG	5322
	GAGTGGCCCTGATGCTCG	5323

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CGAGCATCAGGCCACTC	5324
5 Salt Tolerance HKT1 <i>Triticum aestivum</i> Asn365Ser AAT-AGT	CAGTCTTTGATGGGCTCAGCTCTTATCAGAAGACTGTCAATGCATT CTTCATGGTGGTGAGTGCGAGGCACTCAGGGGAGAATTCCATCG ACTGCTCGCTCATGTCCCCTGCCATTATAGT	5325
	ACTATAATGGCAGGGGACATGAGCGAGCAGTCGATGGAATTCTCC CCTGAGTGCCTCGCACTCACCACCATGAAGAATGCATTGACAGTC TTCTGATAAGAGCTGAGCCCATCAAAGACTG	5326
	GGTGGTGAGTGCGAGGC	5327
	GCCTCGCACTCACCACC	5328
10 Freezing Tolerance proline oxidase precursor <i>Arabidopsis thaliana</i> Arg7Term CGA-TGA	TTTTTTTGTTCGTTTTCAAAAACAAAATCTTTGAATTTTATGGCA ACCCGTCTTCTCTGAACAAACTTTATCCGGCGATCTTACCGTTTAC CCGCTTTTAGCCCGGTGGGTCTCTCCA	5329
	TGGGAGGACCCACCGGGCTAAAAGCGGGTAAACGGTAAGATCGC CGGATAAAGTTTGTTCAGAGAAGACGGGTGGCCATAAAATTCAAA GATTTTGTTCGAAAACGAAAACAAAAAAA	5330
	GTCTTCTCTGAACAAAC	5331
	GTTTGTTCAGAGAAGAC	5332
15 Freezing Tolerance proline oxidase precursor <i>Arabidopsis thaliana</i> Arg13Term CGA-TGA	TCAAAAACAAAATCTTTGAATTTTATGGCAACCCGTCTTCTCAGAA CAAACCTTTATCCGGTGATCTTACCGTTTACCCGCTTTTAGCCCGGT GGGTCTCTCCACCGTGACTGCTTCCACCG	5333
	CGGTGGAAGCAGTCACGGTGGGAGGACCCACCGGGCTAAAAGC GGGTAAACGGTAAGATCACCGGATAAAGTTTGTTCGAGAAGACG GGTTGCCATAAAATTCAAAGATTTGTTTTGA	5334
	TTATCCGGTGATCTTAC	5335
	GTAAGATCACCGGATAA	5336
20 Freezing Tolerance proline oxidase precursor <i>Arabidopsis thaliana</i> Tyr15Term TAC-TAG	AAAATCTTTGAATTTTATGGCAACCCGTCTTCTCCGAACAACTTTA TCCGGCGATCTTAGCGTTTACCCGCTTTAGCCCGGTGGGTCTCTC CCACCGTGACTGCTTCCACCGCCGTCGTC	5337
	GACGACGGCGGTGGAAGCAGTCACGGTGGGAGGACCCACCGGG CTAAAAGCGGGTAAACGCTAAGATCGCCGGATAAAGTTTGTTCGG AGAAGACGGGTGGCCATAAAATTCAAAGATTTT	5338
	CGATCTTAGCGTTTACC	5339
	GGTAAACGCTAAGATCG	5340

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Freezing Tolerance proline oxidase precursor <i>Arabidopsis thaliana</i> Leu17Term TTA-TAA	CTTTGAATTTTATGGCAACCCGTCTTCTCCGAACAACTTTATCCG GCGATCTTACCGTTA <u>A</u> ACCCGCTTTTAGCCCGGTGGGTCCCTCCAC CGTGACTGCTTCCACCGCCGTCGTCCCGGA	5341
	TCCGGGACGACGGCGGTGGAAGCAGTCACGGTGGGAGGACCCA CCGGGCTAAAAGCGGGTTA <u>A</u> ACGGTAAGATCGCCGGATAAAGTTTG TTCGGAGAAGACGGGTGCCATAAAATTCAAAG	5342
	TTACCGTTA <u>A</u> ACCCGCTT	5343
	AAGCGGGTTA <u>A</u> ACGGTAA	5344
10 Freezing Tolerance proline oxidase precursor <i>Arabidopsis thaliana</i> Gly42Term GGA-TGA	CCGGTGGGTCTCTCCACCGTGACTGCTTCCACCGCCGTCGTCCC GGAGATTCTCTCCTTTT <u>I</u> GACAACAAGCACCGGAACCACTCTTCA CCACCCAAAACCCACCGAGCAATCTCACGATG	5345
	CATCGTGAGATTGCTCGGTGGGTTTTGGGTGGTGAAGAGGTGGT TCCGGTGCTTGTGTCA <u>A</u> AAAGGAGAGAATCTCCGGGACGACGGC GGTGAAGCAGTCACGGTGGGAGGACCCACCGG	5346
	TCTCCTTT <u>I</u> GACAACAA	5347
	TTGTTGTCA <u>A</u> AAAGGAGA	5348
15 Lead Tolerance cyclic nucleotide- regulated ion channel <i>Arabidopsis thaliana</i> Arg4Term CGA-TGA	ACATGAAGCAGTGAAATCTCTGTTTGTATTGAATCTTATTAGTCTCA AACTATGAATTTCTGACAAGAGAAGTTTGTAAAGTCAGTGTTCCAG ATTTGTCTCATTGAATTCTAAGTCGTGA	5349
	TCACGACTTAGAATTCAATGAGACAAATCTGGAACACTGACCTTAC AACTTCTCTTGTC <u>A</u> GAAATTCATAGTTTGAGACTAATAAGATTCAA TACAAACAGAGATTTCACTGCTTCATGT	5350
	TGAATTTCT <u>I</u> GACAAGAG	5351
	CTCTTGTC <u>A</u> GAAATTCA	5352
20 Lead Tolerance cyclic nucleotide- regulated ion channel <i>Arabidopsis thaliana</i> Gln5Term CAA-TAA	TGAAGCAGTGAAATCTCTGTTTGTATTGAATCTTATTAGTCTCAAAC TATGAATTTCCGATA <u>A</u> AGAGAAGTTTGTAAAGTCAGTGTTCCAGATT TGCTCATTGAATTCTAAGTCGTGAAGC	5353
	GCTTCACGACTTAGAATTCAATGAGACAAATCTGGAACACTGACCT TACAACTTCTCTT <u>A</u> TCGGAAATTCATAGTTTGAGACTAATAAGATT CAATACAAACAGAGATTTCACTGCTTCA	5354
	ATTTCCGATA <u>A</u> AGAGAAG	5355
	CTTCTCTT <u>A</u> TCGGAAAT	5356
25 Lead Tolerance cyclic nucleotide- regulated ion channel <i>Arabidopsis thaliana</i> Glu6Term GAG-TAG	AGCAGTGAAATCTCTGTTTGTATTGAATCTTATTAGTCTCAAACAT GAATTTCCGACAA <u>T</u> AGAAGTTTGTAAAGTCAGTGTTCCAGATTGT CTCATTGAATTCTAAGTCGTGAAGCTTA	5357
	TAAGCTTCACGACTTAGAATTCAATGAGACAAATCTGGAACACTGA CCTTACAAACTTCT <u>A</u> TTGTCTGGAAATTCATAGTTTGAGACTAATAA GATTCAATACAAACAGAGATTTCACTGCT	5358

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TCCGACAATAGAAGTTT	5359
	AAACTTCTATTGTCGGA	5360
5 Lead Tolerance cyclic nucleotide- regulated ion channel <i>Arabidopsis thaliana</i> Lys7Term AAG-TAG	AGTGAAATCTCTGTTTGTATTGAATCTTATTAGTCTCAAACATGAA TTTCCGACAAGAGTAGTTTGTAAAGGTCAGTGTTCCAGATTGTCTC ATTGAATTCTAAGTCGTGAAGCTTAATT	5361
	AATTAAGCTTCACGACTTAGAATTCAATGAGACAAATCTGGAACAC TGACCTTACAACTACTCTTGTCGGAAATTCATAGTTTGAGACTAA TAAGATTCAATACAAACAGAGATTTCACT	5362
	GACAAGAGTAGTTTGT	5363
	TACAACTACTCTTGTC	5364
10 Lead Tolerance cyclic nucleotide- regulated ion channel <i>Arabidopsis thaliana</i> Gln12Term CAA-TAA	CATTGAATTCTAAGTCGTGAAGCTTAATTCGATTCTTCTTCACTTTC TCGGATCAGGTTTAAAGATTGGAAGTCGGATAAGACTTCCTCCGA CGTGGAATATTCCGGTAAAACGAGATT	5365
	GAATCTCGTTTTACCGGAATATTCCACGTCGGAGGAAGTCTTATC CGACTTCCAATCTTAAACCTGATCCGAGAAAGTGAAGAAGAATC GAATTAAGCTTCACGACTTAGAATTCAATG	5366
	TCAGGTTTAAAGATTGG	5367
	CCAATCTTAAACCTGA	5368
15 Lead Tolerance cyclic nucleotide- gated calmodulin- binding ion channel (CBP4) <i>Nicotiana Tabacum</i> Gln5Term CAA-TAA	TGGAAGTCAATCCCCACGTTGAGCAGGTTGATGCATTGGCTAAA GTTATGAATCACCGCTAAGACGAGTTTGTGAGGTTTCAGGATTGG AAATCAGAGAGAAGCTCTGAGGGAAATTTTC	5369
	GAAAATTTCCCTCAGAGCTTCTCTCTGATTCCAATCCTGAAACCT CACAACTCGTCTTAGCGGTGATTCATAACTTTAGCCAATGCATCA ACCTGCTCAACGTGGGGGATTGACTTCCA	5370
	ATCACCGCTAAGACGAG	5371
	CTCGTCTTAGCGGTGAT	5372
20 Lead Tolerance cyclic nucleotide- gated calmodulin- binding ion channel (CBP4) <i>Nicotiana Tabacum</i> Gly7Term GAG-TAG	TCAATCCCCACGTTGAGCAGGTTGATGCATTGGCTAAAGTTATG AATCACCGCCAAGACTAGTTTGTGAGGTTTCAGGATTGGAAATCA GAGAGAAGCTCTGAGGGAAATTTTCATGCTA	5373
	TAGCATGAAAATTTCCCTCAGAGCTTCTCTCTGATTCCAATCCTG AAACCTCACAACTAGTCTTGGCGGTGATTCATAACTTTAGCCAAT GCATCAACCTGCTCAACGTGGGGGATTGA	5374
	GCCAAGACTAGTTTGTG	5375
	CACAACTAGTCTTGGC	5376

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Lead Tolerance cyclic nucleotide- gated calmodulin- binding ion channel (CBP4) <i>Nicotiana Tabacum</i> Gln12Term CAG-TAG	GAGCAGGTTGATGCATTGGCTAAAGTTATGAATCACCGCCAAGAC GAGTTTGTGAGGTTT <u>I</u> AGGATTGGAAATCAGAGAGAAGCTCTGAG GGAAATTTTCATGCTAAAGGTGGAGTCCACC	5377
	GGTGGACTCCACCTTTAGCATGAAAATTTCCCTCAGAGCTTCTCTC TGATTTCCAATCCT <u>A</u> AAACCTCACAACTCGTCTTGGCGGTGATT ATAACTTTAGCCAATGCATCAACCTGCTC	5378
	TGAGGTTT <u>I</u> AGGATTGG	5379
	CCAATCCT <u>A</u> AAACCTCA	5380
10 Lead Tolerance cyclic nucleotide- gated calmodulin- binding ion channel (CBP4) <i>Nicotiana Tabacum</i> Trp14Term TGG-TGA	TGATGCATTGGCTAAAGTTATGAATCACCGCCAAGACGAGTTTGT GAGGTTTCAGGATTG <u>T</u> AAATCAGAGAGAAGCTCTGAGGGAAATTT TCATGCTAAAGGTGGAGTCCACCGAAGTAAA	5381
	TTTACTTCGGTGGACTCCACCTTTAGCATGAAAATTTCCCTCAGAG CTTCTCTCTGATT <u>A</u> CAATCCTGAAACCTCACAACTCGTCTTGGC GGTGATTCATAACTTTAGCCAATGCATCA	5382
	CAGGATTG <u>T</u> AAATCAGA	5383
	TCTGATT <u>A</u> CAATCCTG	5384
20 Lead Tolerance cyclic nucleotide- gated calmodulin- binding ion channel (CBP4) <i>Nicotiana Tabacum</i> Lys15Term AAA-TAA	GATGCATTGGCTAAAGTTATGAATCACCGCCAAGACGAGTTTGTG AGGTTTCAGGATTGG <u>T</u> AATCAGAGAGAAGCTCTGAGGGAAATTT CATGCTAAAGGTGGAGTCCACCGAAGTAAAG	5385
	CTTACTTCGGTGGACTCCACCTTTAGCATGAAAATTTCCCTCAGA GCTTCTCTCTGATT <u>A</u> CCAATCCTGAAACCTCACAACTCGTCTTGG CGGTGATTCATAACTTTAGCCAATGCATC	5386
	AGGATTGG <u>T</u> AATCAGAG	5387
	CTCTGATT <u>A</u> CCAATCCT	5388
25 Lead Tolerance calmodulin binding transport protein <i>Hordeum vulgare</i> Glu2Term GAA-TAA	CTTGAAGAATTGATCTACCACTCTTAGCTGCTAACTGTTGCCTGG TGGAGATAATGATG <u>T</u> AAAGAGAGGACAGATATGTTAGATTTAGGA CTGCAAATCAGAGCAATCTGTTATCTCAG	5389
	CTGAGATAACAGATTGCTCTGATTTGCAGTCCTGAAATCTAACATA TCTGTCCTCTCTT <u>A</u> CATCATTATCTCCACCAGGCGAACAGTTAGC AGCTAAGAGTGGTAGATCAATTCTTCAAG	5390
	TAATGATG <u>T</u> AAAGAGAG	5391
	CTCTCTTT <u>A</u> CATCATTA	5392

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Lead Tolerance calmodulin binding transport protein <i>Hordeum vulgare</i> Arg3Term AGA-TGA	GAAGAATTGATCTACCACTCTTAGCTGCTAACTGTTGCGCTGGTG GAGATAATGATGGAATGAGAGGACAGATATGTTAGATTTCAAGAC TGCAAATCAGAGCAATCTGTTATCTCAGAGA	5393
	TCTCTGAGATAACAGATTGCTCTGATTTGCAGTCCTGAAATCTAAC ATATCTGTCCTCTCATTCATCATTATCTCCACCAGGCGAACAGTT AGCAGCTAAGAGTGGTAGATCAATTCTTC	5394
	TGATGGAATGAGAGGAC	5395
	GTCCTCTCATTCATCA	5396
10 Lead Tolerance calmodulin binding transport protein <i>Hordeum vulgare</i> Glu4Term GAG-TAG	GAATTGATCTACCACTCTTAGCTGCTAACTGTTGCGCTGGTGGAG ATAATGATGGAAAGATAGGACAGATATGTTAGATTTCAAGACTGCA AATCAGAGCAATCTGTTATCTCAGAGAACG	5397
	CGTTCTCTGAGATAACAGATTGCTCTGATTTGCAGTCCTGAAATCT AACATATCTGTCCTATCTTCCATCATTATCTCCACCAGGCGAAC GTTAGCAGCTAAGAGTGGTAGATCAATTC	5398
	TGGAAGATAGGACAGA	5399
	TCTGTCCTATCTTTCCA	5400
15 Lead Tolerance calmodulin binding transport protein <i>Hordeum vulgare</i> Arg6Term AGA-TGA	ATCTACCACTCTTAGCTGCTAACTGTTGCGCTGGTGGAGATAATG ATGGAAGAGAGGACTGATATGTTAGATTTCAAGACTGCAAATCA GAGCAATCTGTTATCTCAGAGAACGCAGTTT	5401
	AACTGCGTTCTCTGAGATAACAGATTGCTCTGATTTGCAGTCCTG AAATCTAACATATCAGTCCTCTCTTCCATCATTATCTCCACCAGG CGAACAGTTAGCAGCTAAGAGTGGTAGAT	5402
	GAGAGGACTGATATGTT	5403
	AACATATCAGTCCTCTC	5404
20 Lead Tolerance calmodulin binding transport protein <i>Hordeum vulgare</i> Tyr7Term TAT-TAG	CCTCTTAGCTGCTAACTGTTGCGCTGGTGGAGATAATGATGGA AAGAGAGGACAGATAGGTTAGATTTCAAGACTGCAAATCAGAGCA ATCTGTTATCTCAGAGAACGCAGTTTCACCA	5405
	TGGTGAACTGCGTTCTCTGAGATAACAGATTGCTCTGATTTGCAG TCCTGAAATCTAACCTATCTGTCCTCTCTTCCATCATTATCTCCAC CAGGCGAACAGTTAGCAGCTAAGAGTGG	5406
	GACAGATAGGTTAGATT	5407
	AATCTAACCTATCTGTC	5408
25 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Arabidopsis thaliana</i> Glu2Term GAG-TAG	ATCCTTCTCTGAGAAAAACAACAGATCCGAATTTATCTTTAATCA GCCGGAATAATGTAGAAAGCGATCGAGAGACAACGCGTTCTTCT TGAGCATCTCCGACCTTCTTCTTCTTCTT	5409
	AAGAAGAAGAAGAAGGTCGAGATGCTCAAGAAGAACGCGTTGTC TCTCGATCGCTTCTACATTTTTCCGGCTGATTAAAGATAAAATTC GGATCTGTTGTTTTCTCAGAGAAGGAT	5410

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	AAAAAATG <u>T</u> AGAAAGCG	5411
	CGCTTTCT <u>A</u> CATTTTTT	5412
2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Arabidopsis thaliana</i> Lys3Term AAA-TAA	CTTCTCTGAGAAAAACAACAGATCCGAATTTTATCTTTAATCAGC CGGAAAAAATGGAGT <u>A</u> AGCGATCGAGAGACAACGCGTTCTTCTTG AGCATCTCCGACCTTCTTCTTCTTCTTCGC	5413
	GCGAAGAAGAAGAAGAAGGTGCGAGATGCTCAAGAAGAACGCGT TGTCTCTCGATCGCTT <u>A</u> CTCCATTTTTTCCGGCTGATTAAAGATAA AATTCGGATCTGTTGTTTTTCTCAGAGAAG	5414
	AAATGGAGT <u>A</u> AGCGATC	5415
	GATCGCTT <u>A</u> CTCCATT	5416
2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Arabidopsis thaliana</i> Glu6Term GAG-TAG	GAAAAACAACAGATCCGAATTTTATCTTTAATCAGCCGGAAAAAA TGGAGAAAGCGATCTAGAGACAACGCGTTCTTCTTGAGCATCTCC GACCTTCTTCTTCTTCTTCGCACAATTACG	5417
	CGTAATTGTGCGAAGAAGAAGAAGGTGCGAGATGCTCAAGAA GAACGCGTTGTCTCT <u>A</u> GATCGCTTTCTCCATTTTTTCCGGCTGATT AAAGATAAAATTCGGATCTGTTGTTTTTC	5418
	AAGCGATC <u>T</u> AGAGACAA	5419
	TTGTCTCT <u>A</u> GATCGCTT	5420
2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Arabidopsis thaliana</i> Arg7Term AGA-TGA	AAAACAACAGATCCGAATTTTATCTTTAATCAGCCGGAAAAAATGG AGAAAGCGATCGAGT <u>G</u> ACAACGCGTTCTTCTTGAGCATCTCCGAC CTTCTTCTTCTTCTTCGCACAATTACGAGG	5421
	CCTCGTAATTGTGCGAAGAAGAAGAAGGTGCGAGATGCTCAA GAAGAACGCGTTGTCT <u>A</u> CTCGATCGCTTTCTCCATTTTTTCCGGCT GATTAAAGATAAAATTCGGATCTGTTGTTTT	5422
	CGATCGAGT <u>G</u> ACAACGC	5423
	GCGTTGTCT <u>A</u> CTCGATCG	5424
2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Arabidopsis thaliana</i> Gln8Term CAA-TAA	ACAACAGATCCGAATTTTATCTTTAATCAGCCGGAAAAAATGGAGA AAGCGATCGAGAGAT <u>A</u> ACGCGTTCTTCTTGAGCATCTCCGACCTT CTTCTTCTTCTTCGCACAATTACGAGGCTT	5425
	AAGCCTCGTAATTGTGCGAAGAAGAAGAAGGTGCGAGATGCT CAAGAAGAACGCGTT <u>A</u> TCTCTCGATCGCTTTCTCCATTTTTTCCGG CTGATTAAAGATAAAATTCGGATCTGTTGT	5426
	TCGAGAGAT <u>A</u> ACGCGTT	5427
	AACGCGTT <u>A</u> TCTCTCGA	5428

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 2,4-DB resistance glyoxysomal beta- ketoacyl-thiolase precursor <i>Brassica napus</i> Glu26Term GAA-TAA	GAGAGACAAAGAGTTCTTCTTGAACATCTCCGTCCTTCTTCTTCTT CCTCTCACAGCTTTTAAAGGCTCTCTCTGCTTCAGCTTGCTTGGC TGGGGACAGTGCTGCGTATCAGAGGACCT	5429
	AGGTCCTCTGATACGCAGCACTGTCCCCAGCCAAGCAAGCTGAA GCAGAGAGAGAGCCTTAAAAGCTGTGAGAGGAAGAAGAAGAAGG ACGGAGATGTTCAAGAAGAACTCTTTGTCTCTC	5430
	ACAGCTTTTAAAGGCTCT	5431
	AGAGCCTTAAAAGCTGT	5432
10 2,4-DB resistance glyoxysomal beta- ketoacyl-thiolase precursor <i>Brassica napus</i> Ser32Term TCA-TGA	TTGAACATCTCCGTCCTTCTTCTTCTTCTTCTCTCACAGCTTTGAAGG CTCTCTCTCTGCTTGAAGCTTGCTTGGCTGGGGACAGTGCTGCGTA TCAGAGGACCTCTCTCTATGGAGATGATGT	5433
	ACATCATCTCCATAGAGAGAGGTCCTCTGATACGCAGCACTGTCC CCAGCCAAGCAAGCTCAAGCAGAGAGAGAGCCTTCAAAGCTGTG AGAGGAAGAAGAAGAAGGACGGAGATGTTCAA	5434
	CTCTGCTTGAAGCTTGCT	5435
	AGCAAGCTCAAGCAGAG	5436
15 20 2,4-DB resistance glyoxysomal beta- ketoacyl-thiolase precursor <i>Brassica napus</i> Cys34Term TGC-TGA	TCTCCGTCCTTCTTCTTCTTCTTCTCTCACAGCTTTGAAGGCTCTCTC TCTGCTTCAGCTTGATTGGCTGGGGACAGTGCTGCGTATCAGAG GACCTCTCTCTATGGAGATGATGTAGTCATT	5437
	AATGACTACATCATCTCCATAGAGAGAGGTCCTCTGATACGCAGC ACTGTCCCCAGCCAATCAAGCTGAAGCAGAGAGAGAGCCTTCAAA GCTGTGAGAGGAAGAAGAAGAAGGACGGAGA	5438
	TCAGCTTGATTGGCTGG	5439
	CCAGCCAATCAAGCTGA	5440
25 2,4-DB resistance glyoxysomal beta- ketoacyl-thiolase precursor <i>Brassica napus</i> Leu35Term TTG-TAG	TCCGTCCTTCTTCTTCTTCTTCTCTCACAGCTTTGAAGGCTCTCTCTC TGCTTCAGCTTGCTAGGCTGGGGACAGTGCTGCGTATCAGAGGA CCTCTCTCTATGGAGATGATGTAGTCATTGT	5441
	ACAATGACTACATCATCTCCATAGAGAGAGGTCCTCTGATACGCA GCACTGTCCCCAGCCTAGCAAGCTGAAGCAGAGAGAGAGCCTTC AAAGCTGTGAGAGGAAGAAGAAGAAGGACGGA	5442
	AGCTTGCTAGGCTGGGG	5443
	CCCCAGCCTAGCAAGCT	5444

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 2,4-DB resistance glyoxysomal beta- ketoacyl-thiolase precursor <i>Brassica napus</i> Tyr42Term TAT-TAG	TCACAGCTTTGAAGGCTCTCTCTGCTTCAGCTTGCTTGGCTGG GGACAGTGCTGCGTAGCAGAGGACCTCTCTCTATGGAGATGATGT AGTCATTGTTGCGGCACATAGGACTGCACTA	5445
	TAGTGCAGTCCTATGTGCCGCAACAATGACTACATCATCTCCATA GAGAGAGGTCTCTGCTACGCAGCACTGTCCCCAGCCAAGCAAG CTGAAGCAGAGAGAGAGCCCTTCAAAGCTGTGA	5446
	GCTGCGTAGCAGAGGAC	5447
	GTCCTCTGCTACGCAGC	5448
10 2,4-DB resistance 3-ketoacyl-CoA thiolase B <i>Mangifera indica</i> Tyr25Term TAC-TAG	CAACAGACAGCAAGTGTTGCTCCAGCATCTCCGCCCTTCTAATTC TTCTTCTCACAATTAGGAGTCCGCTCTTGCCGCATCAGTATGTGCT GCAGGGGATAGCGCCGCATATCATAGGGCT	5449
	AGCCCTATGATATGCGGCGCTATCCCCTGCAGCACATACTGATGC GGCAAGAGCGGACTCCTAATTGTGAGAAGAAGAATTAGAAGGGC GGAGATGCTGGAGCAACACTTGCTGTCTGTTG	5450
	CACAATTAGGAGTCCGC	5451
	GCGGACTCCTAATTGTG	5452
15 2,4-DB resistance 3-ketoacyl-CoA thiolase B <i>Mangifera indica</i> Glu26Term GAG-TAG	AACAGACAGCAAGTGTTGCTCCAGCATCTCCGCCCTTCTAATTCTT CTTCTCACAATTACTAGTCCGCTCTTGCCGCATCAGTATGTGCTG CAGGGGATAGCGCCGCATATCATAGGGCTT	5453
	AAGCCCTATGATATGCGGCGCTATCCCCTGCAGCACATACTGATG CGGCAAGAGCGGACTAGTAATTGTGAGAAGAAGAATTAGAAGGG CGGAGATGCTGGAGCAACACTTGCTGTCTGTT	5454
	ACAATTACTAGTCCGCT	5455
	AGCGGACTAGTAATTGT	5456
20 25 2,4-DB resistance 3-ketoacyl-CoA thiolase B <i>Mangifera indica</i> Ser32Term TCA-TGA	TCCAGCATCTCCGCCCTTCTAATTCTTCTTCTCACAATTACGAGTC CGCTCTTGCCGCATGAGTATGTGCTGCAGGGGATAGCGCCGCAT ATCATAGGGCTTCTGTTTATGGAGACGATGT	5457
	ACATCGTCTCCATAAACAGAAGCCCTATGATATGCGGCGCTATCC CCTGCAGCACATACTCATGCGGCAAGAGCGGACTCGTAATTGTGA GAAGAAGAATTAGAAGGGCGGAGATGCTGGA	5458
	TGCCGCATGAGTATGTG	5459
	CACATACTCATGCGGCA	5460

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 2,4-DB resistance 3-ketoacyl-CoA thiolase B <i>Mangifera indica</i> Cys34Term TGT-TGA	TCTCCGCCCTTCTAATTCTTCTCTCACAATTACGAGTCCGCTCTT GCCGCATCAGTATGAGCTGCAGGGGATAGCGCCGCATATCATAG GGCTTCTGTTTATGGAGACGATGTGGTGATT	5461
	AATCACCACATCGTCTCCATAAACAGAAGCCCTATGATATGCGGC GCTATCCCCTGCAGCTCATACTGATGCGGCAAGAGCGGACTCGT AATTGTGAGAAGAAGAATTAGAAGGGCGGAGA	5462
	TCAGTATGAGCTGCAGG	5463
	CCTGCAGCTCATACTGA	5464
10 2,4-DB resistance 3-ketoacyl-CoA thiolase B <i>Mangifera indica</i> Tyr42Term TAT-TAG	TCACAATTACGAGTCCGCTCTTGCCGCATCAGTATGTGCTGCAGG GGATAGCGCCGCATAGCATAGGGCTTCTGTTTATGGAGACGATGT GGTGATTGTGGCAGCTCATCGTACTGCACTT	5465
	AAGTGCAGTACGATGAGCTGCCACAATCACCACATCGTCTCCATA AACAGAAGCCCTATGCTATGCGGCGCTATCCCCTGCAGCACATAC TGATGCGGCAAGAGCGGACTCGTAATTGTGA	5466
	GCCGCATAGCATAGGGC	5467
	GCCCTATGCTATGCGGC	5468
15 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucumis sativus</i> Tyr22Term TAC-TAG	GAAGGCGATCAACAGGCAGAGCATTTTGCTACATCATCTCCGGCC TTCTTCTTCCGCTTAGACAAATGAATCTTCGCTCTCTGCATCGGTT TGTGCAGCTGGGGATAGTGCTTCGTATCAA	5469
	TTGATACGAAGCACTATCCCCAGCTGCACAAACCGATGCAGAGAG CGAAGATTCATTTGTCTAAGCGGAAGAAGAAGGCCGGAGATGATG TAGCAAATGCTCTGCCTGTTGATCGCCTTC	5470
	TCCGCTTAGACAAATGA	5471
	TCATTTGTCTAAGCGGA	5472
20 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucumis sativus</i> Glu25Term GAA-TAA	ATCAACAGGCAGAGCATTTTGCTACATCATCTCCGGCCTTCTTCTT CCGCTTACACAAATTAATCTTCGCTCTCTGCATCGGTTTGTGCAGC TGGGGATAGTGCTTCGTATCAAAGGACAT	5473
	ATGTCCTTTGATACGAAGCACTATCCCCAGCTGCACAAACCGATG CAGAGAGCGAAGATTAAATTTGTGTAAGCGGAAGAAGAAGGCCGG AGATGATGTAGCAAATGCTCTGCCTGTTGAT	5474
	ACACAAATTAATCTTCG	5475
	CGAAGATTAAATTTGTGT	5476

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucumis sativus</i> Ser27Term TCG-TAG	GGCAGAGCA T TTTGCTACATCATCTCCGGCCTTCTTCTTCCGCTTA CACAAATGAATCTT A GCTCTCTGCATCGGTTTGTGCAGCTGGGGA TAGTGCTTCGTATCAAAGGACATCGGTGTT	5477
	AACACCGATGTCCTTTGATACGAAGCACTATCCCCAGCTGCACAA ACCGATGCAGAGAGCT A AAGATTCATTTGTGTAAGCGGAAGAAGAA GGCCGGAGATGATGTAGCAAATGCTCTGCC	5478
	TGAATCTT A GCTCTCTG	5479
	CAGAGAGCT A AAGATTCA	5480
10 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucumis sativus</i> Ser31Term TCG-TAG	TGCTACATCATCTCCGGCCTTCTTCTTCCGCTTACACAAATGAATC TTCGCTCTCTGCAT A GGTTTGTGCAGCTGGGGATAGTGCTTCGTA TCAAAGGACATCGGTGTTTGGAGATGATGT	5481
	ACATCATCTCCAAACACCGATGTCCTTTGATACGAAGCACTATCCC CAGCTGCACAAACCT A TGCAGAGAGCGAAGATTCATTTGTGTAAG CGGAAGAAGAAGGCCGGAGATGATGTAGCA	5482
	CTCTGCAT A GGTTTGTG	5483
	CACAAACCT A TGCAGAG	5484
15 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucumis sativus</i> Cys33Term TGT-TGA	TCATCTCCGGCCTTCTTCTTCCGCTTACACAAATGAATCTTCGCTC TCTGCATCGGTTT G AGCAGCTGGGGATAGTGCTTCGTATCAAAGG ACATCGGTGTTTGGAGATGATGTCGTGATT	5485
	AATCACGACATCATCTCCAAACACCGATGTCCTTTGATACGAAGCA CTATCCCCAGCTGCT C AAACCGATGCAGAGAGCGAAGATTCATTT GTGTAAGCGGAAGAAGAAGGCCGGAGATGA	5486
	TCGGTTT G AGCAGCTGG	5487
	CCAGCTGCT C AAACCGA	5488
20 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucurbita sp.</i> Tyr22Term TAT-TAG	GAAGGCAATCAACAGGCAGAGCATTCTGCTACATCATCTCCGGCC TTCATCTTCGGCTT A GAGCCATGAATCTTCGCTCTCTGCATCGGTT TGTGCAGCTGGGGATAGTGCGTCGTATCAA	5489
	TTGATACGACGCACTATCCCCAGCTGCACAAACCGATGCAGAGAG CGAAGATTCATGGCT C TAAGCCGAAGATGAAGGCCGGAGATGAT GTAGCAGAATGCTCTGCCTGTTGATTGCCTTC	5490
	TCGGCTT A GAGCCATGA	5491
	TCATGGCT C TAAGCCGA	5492

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucurbita</i> sp. Glu25Term GAA-TAA	ATCAACAGGCAGAGCATTCTGCTACATCATCTCCGGCCTTCATCTT CGGCTTATAGCCATTAAATCTTCGCTCTCTGCATCGGTTTGTGCAG CTGGGGATAGTGCGTCGTATCAAAGAACGT	5493
	ACGTTCTTTGATACGACGCACTATCCCCAGCTGCACAAACCGATG CAGAGAGCGAAGATTAAATGGCTATAAGCCGAAGATGAAGGCCGG AGATGATGTAGCAGAATGCTCTGCCTGTTGAT	5494
	ATAGCCATTAAATCTTCG	5495
	CGAAGATTAAATGGCTAT	5496
10 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucurbita</i> sp. Ser27Term TCG-TAG	GGCAGAGCATTCTGCTACATCATCTCCGGCCTTCATCTTCGGCTT ATAGCCATGAATCTTAGCTCTCTGCATCGGTTTGTGCAGCTGGGG ATAGTGCGTCGTATCAAAGAACGTCCGGTGT	5497
	AACACCGACGTTCTTTGATACGACGCACTATCCCCAGCTGCACAA ACCGATGCAGAGAGCTAAGATTTCATGGCTATAAGCCGAAGATGAA GGCCGGAGATGATGTAGCAGAATGCTCTGCC	5498
	TGAATCTTAGCTCTCTG	5499
	CAGAGAGCTAAGATTCA	5500
15 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucurbita</i> sp. Ser31Term TCG-TAG	TGCTACATCATCTCCGGCCTTCATCTTCGGCTTATAGCCATGAATC TTCGCTCTCTGCATAGGTTTGTGCAGCTGGGGATAGTGCGTCGTA TCAAAGAACGTCCGGTGTGGAGATGATGT	5501
	ACATCATCTCCAAACACCGACGTTCTTTGATACGACGCACTATCCC CAGCTGCACAAACCTATGCAGAGAGCGAAGATTTCATGGCTATAAG CCGAAGATGAAGGCCGGAGATGATGTAGCA	5502
	CTCTGCATAGGTTTGTG	5503
	CACAAACCTATGCAGAG	5504
20 2,4-DB resistance 3-ketoacyl-CoA thiolase <i>Cucurbita</i> sp. Cys33Term TGT-TGA	TCATCTCCGGCCTTCATCTTCGGCTTATAGCCATGAATCTTCGCTC TCTGCATCGGTTTGAGCAGCTGGGGATAGTGCGTCGTATCAAAGA ACGTCCGGTGTGGAGATGATGTCGTGATA	5505
	TATCACGACATCATCTCCAAACACCGACGTTCTTTGATACGACGCA CTATCCCAGCTGCTCAAACCGATGCAGAGAGCGAAGATTTCATGG CTATAAGCCGAAGATGAAGGCCGGAGATGA	5506
	TCGGTTTGAGCAGCTGG	5507
	CCAGCTGCTCAAACCGA	5508
25 2,4 DB resistance Pex14 <i>Arabidopsis thaliana</i> Gln5Term CAG-TAG	TCATAGTCTCTTTGCCGCTTGGATTCTTCCAAGGTTAGTGAGCTG CTATGGCAACTCATTAGCAAACGCAACCTCCTTCCGATTTTCCCG CTCTTGCCGATGAAAATCCAGATTCCAG	5509
	CTGGAATCTGGAATTTTCATCGGCAAGAGCGGGAAAATCGGAAG GAGGTTGCGTTTGCTAATGAGTTGCCATAGCAGCTCACTAACCTT GGAAGAATCCAAGCGGCAAAAGAGACTATGA	5510

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
2,4 DB resistance Pex14 <i>Arabidopsis thaliana</i> Gln6Term CAA-TAA	CAACTCAT <u>I</u> AGCAAACG	5511
	CGTTTGCTAATGAGTTG	5512
	TAGTCTCTTTTGGCGCTTGGATTCTTCCAAGGTTAGTGAGCTGCTA TGGCAACTCATCAGTAAACGCAACCTCCTTCCGATTTTCCCGCTC TTGCCGATGAAAATTCCCAGATTCCAGGTT	5513
	AACCTGGAATCTGGGAATTTTCATCGGCAAGAGCGGGAAAATCGG AAGGAGGTTGCGTTTACTGATGAGTTGCCATAGCAGCTCACTAAC CTTGGAAGAATCCAAGCGGCAAAAGAGACTA	5514
	CTCATCAGTAAACGCAA	5515
	TTGCGTTTACTGATGAG	5516
2,4 DB resistance Pex14 <i>Arabidopsis thaliana</i> Gln8Term CAA-TAA	CTTTTGGCGCTTGGATTCTTCCAAGGTTAGTGAGCTGCTATGGCA ACTCATCAGCAAACGTAACCTCCTTCCGATTTTCCCGCTCTTGCC GATGAAAATTCCCAGATTCCAGGTTCAATTT	5517
	AAATTGAACCTGGAATCTGGGAATTTTCATCGGCAAGAGCGGGAA AATCGGAAGGAGGTTACGTTTGCTGATGAGTTGCCATAGCAGCTC ACTAACCTTGGAAGAATCCAAGCGGCAAAAG	5518
	AGCAAACGTAACCTCCT	5519
	AGGAGGTTACGTTTGCT	5520
2,4 DB resistance Pex14 <i>Arabidopsis thaliana</i> Glu19Term GAA-TAA	GCTGCTATGGCAACTCATCAGCAAACGCAACCTCCTTCCGATTTT CCCGCTCTTGCCGATTAAATTTCCCAGATTCCAGGTTCAATTTACA CCTTCTAATCATTATTTCTTAATTTTCTT	5521
	AAGAAAAATTAAGAAATAATGATTAGAAGGTGTAAATTGAACCTGG AATCTGGGAATTTTAATCGGCAAGAGCGGGAAAATCGGAAGGAG GTTGCGTTTGCTGATGAGTTGCCATAGCAGC	5522
	TTGCCGATTAAATTTCC	5523
	GGAATTTTAATCGGCAA	5524
2,4 DB resistance Pex14 <i>Arabidopsis thaliana</i> Gln22Term CAG-TAG	GCAACTCATCAGCAAACGCAACCTCCTTCCGATTTTCCCGCTCTT GCCGATGAAAATTCCTAGATTCCAGGTTCAATTTACACCTTCTAAT CATTATTTCTTAATTTTCTTTGGTGGATT	5525
	AATCCACCAAAGAAAAATTAAGAAATAATGATTAGAAGGTGTAAATT GAACCTGGAATCTAGGAATTTTCATCGGCAAGAGCGGGAAAATCG GAAGGAGGTTGCGTTTGCTGATGAGTTGC	5526
	AAAATTCCTAGATTCCA	5527
	TGGAATCTAGGAATTTT	5528

Example 8**Production of albino mutants for the analysis of photosynthetic processes**

Plant productivity is limited by resources available and the ability of plants to harness these resources. The conversion of light to chemical energy, which is then used to synthesize carbohydrates, fatty acids, sugars, amino acids and other compounds, requires a complex system which combines the light harvesting apparatus of pigments and proteins. The value of light energy to the plant can only be realized when it is efficiently converted into chemical energy by photosynthesis and fed into various biochemical processes. Significant effort has therefore been directed at studying photosynthetic processes in plants in order to improve productivity and/or the efficiency of photosynthesis. The analysis of the photosynthetic process is substantially aided by the ability to produce albino plants.

The attached table discloses exemplary oligonucleotide base sequences which can be used to generate site-specific mutations in genes involved in starch metabolism.

Table 18
Oligonucleotides to produce albino plants

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 10 White leaves Immutans <i>Arabidopsis thaliana</i> Ser5Term TCA-TGA	TTCTTTCTGTGAAATTATCTGCTCAAATCTTTGGTTCTTGACGGAG ATGGCGGCGATTTGAGGCATCTCCTCTGGTACGTTGACGATTTC CGGCCTTTGGTTACTCTTCGACGCTCTAG	5529
	CTAGAGCGTCGAAGAGTAACCAAAGGCCGTGAAATCGTCAACGTA CCAGAGGAGATGCCTCAAATCGCCGCCATCTCCGTGAGGAACCAA AGATTTGAGCAGATAATTTACAGGAAAGAA	5530
	GGCGATTTGAGGCATCT	5531
	AGATGCCTCAAATCGCC	5532
15 White leaves Immutans <i>Arabidopsis thaliana</i> Leu12Term TTG-TAG	GCTCAAATCTTTGGTTCTTGACGGAGATGGCGGCGATTTACGGCA TCTCCTCTGGTACGTAGACGATTTACGGCCTTTGGTTACTCTTCG ACGCTCTAGAGCCGCCGTTTCGTACAGCTC	5533
	GAGCTGTACGAAACGGCGGCTCTAGAGCGTCGAAGAGTAACCAA GGCCGTGAAATCGTCTACGTACCAGAGGAGATGCCTGAAATCGCC GCCATCTCCGTGAGGAACCAAAGATTTGAGC	5534
	TGGTACGTAGACGATTT	5535
	AAATCGTCTACGTACCA	5536
20 White leaves Immutans <i>Arabidopsis thaliana</i> Ser15Term TCA-TGA	TTTGGTTCTTGACGGAGATGGCGGCGATTTACGGCATCTCCTCTG GTACGTTGACGATTTGACGGCCTTTGGTTACTCTTCGACGCTCTAG AGCCGCCGTTTCGTACAGCTCCTCTCACCG	5537
	CGGTGAGAGGAGCTGTACGAAACGGCGGCTCTAGAGCGTCGAAG AGTAACCAAAGGCCGTCAAATCGTCAACGTACCAGAGGAGATGCC TGAAATCGCCGCCATCTCCGTGAGGAACCAA	5538
	GACGATTTGACGGCCTT	5539
	AAGGCCGTCAAATCGTC	5540
25 White leaves Immutans <i>Arabidopsis thaliana</i> Arg22Term CGA-TGA	GCGGCGATTTACGGCATCTCCTCTGGTACGTTGACGATTTACGG CCTTTGGTTACTCTTIGACGCTCTAGAGCCGCCGTTTCGTACAGCT CCTCTACCGATTGCTTCATCATCTTCCTC	5541
	GAGGAAGATGATGAAGCAATCGGTGAGAGGAGCTGTACGAAACG GCGGCTCTAGAGCGTCAAAGAGTAACCAAAGGCCGTGAAATCGTC AACGTACCAGAGGAGATGCCTGAAATCGCCGC	5542
	TACTCTTIGACGCTCT	5543
	AGAGCGTCAAAGAGTAA	5544

5	White leaves Immutans <i>Arabidopsis thaliana</i> Arg25Term AGA-TGA	TCAGGCATCTCCTCTGGTACGTTGACGATTTACGGCCTTTGGTTA CTCTTCGACGCTCTTGAGCCGCCGTTTCGTACAGCTCCTCTCACC GATTGCTTCATCATCTTCCTCTCTCTCTC	5545
		GAGAAGAGAGAGGAAGATGATGAAGCAATCGGTGAGAGGAGCTG TACGAAACGGCGGCTCAAGAGCGTCGAAGAGTAACCAAAGGCCG TGAAATCGTCAACGTACCAGAGGAGATGCCTGA	5546
		GACGCTCTTGAGCCGCC	5547
		GGCGGCTCAAGAGCGTC	5548
10	White leaves Immutans <i>Lycopersicon</i> <i>esculentum</i> Gly11Term GGA-TGA	GATTCTTGTGGGAAGGAAGAAGGATCAAGAATGGCGATTTGATTT CTGCTATGAGTTTTGAACCTCAGTTTCTTCATATTCTTGTTTTAGA GCTAGGAGTTTTGAGAAGTCATCAGTTT	5549
		AAACTGATGACTTCTCAAACTCCTAGCTCTAAACAAGAATATGAA GAACTGAGGTTCAAAACTCATAGCAGAAATCGAAATCGCCATTC TTGATCCTTCTCCTTCCCACAAGAATC	5550
		TGAGTTTTGAACCTCA	5551
		TGAGGTTCAAAACTCA	5552
15	White leaves Immutans <i>Lycopersicon</i> <i>esculentum</i> Ser13Term TCA-TGA	GTGGGAAGGAAGAAGGATCAAGAATGGCGATTTGATTTCTGCTA TGAGTTTTGGAACCTGAGTTTCTTCATATTCTTGTTTTAGAGCTAGG AGTTTTGAGAAGTCATCAGTTTTATGCAA	5553
		TTGCATAAACTGATGACTTCTCAAACTCCTAGCTCTAAACAAGA ATATGAAGAACTCAGGTTCCAAACTCATAGCAGAAATCGAAATC GCCATTCTTGATCCTTCTTCCCTCCAC	5554
		TGGAACCTGAGTTTCTT	5555
		AAGAACTCAGGTTCCA	5556
20	White leaves Immutans <i>Lycopersicon</i> <i>esculentum</i> Ser16Term TCA-TGA	AAGAAGGATCAAGAATGGCGATTTGATTTCTGCTATGAGTTTTGG AACCTCAGTTTCTTGATATTCTTGTTTTAGAGCTAGGAGTTTTGAGA AGTCATCAGTTTTATGCAATCCCAGAA	5557
		TTCTGGGAATTGCATAAACTGATGACTTCTCAAACTCCTAGCTC TAAACAAGAATATCAAGAACTGAGGTTCCAAACTCATAGCAGA AATCGAAATCGCCATTCTTGATCCTTCTT	5558
		AGTTTCTTGATATTCTT	5559
		AAGAATATCAAGAACT	5560
25	White leaves Immutans <i>Lycopersicon</i> <i>esculentum</i> Tyr17Term TAT-TAG	AGGATCAAGAATGGCGATTTGATTTCTGCTATGAGTTTTGGAACC TCAGTTTCTTCATAGTCTTGTTTTAGAGCTAGGAGTTTTGAGAAGTC ATCAGTTTTATGCAATCCCAGAACCCA	5561
		TGGGTTCTGGGAATTGCATAAACTGATGACTTCTCAAACTCCTA GCTCTAAACAAGACTATGAAGAACTGAGGTTCCAAACTCATAG CAGAAATCGAAATCGCCATTCTTGATCCT	5562
		TCTTCATAGTCTTGTTT	5563
		AAACAAGACTATGAAGA	5564

5	White leaves Immutans <i>Lycopersicon esculentum</i> Cys19Term TGT-TGA	AAGAATGGCGATTTCGATTCTGCTATGAGTTTTGGAACCTCAGTT TCTTCATATTCTTGATTAGAGCTAGGAGTTTTGAGAAGTCATCAGT TTTATGCAATCCCAGAACCCATGTCGG	5565
		CCGACATGGGTTCTGGGAATTGCATAAACTGATGACTTCTCAAAA CTCCTAGCTCTAAATCAAGAATATGAAGAACTGAGGTTCCAAAAC TCATAGCAGAAATCGAAATCGCCATTCTT	5566
		TATTCTTGATTAGAGC	5567
		GCTCTAAATCAAGAATA	5568
10	White leaves Immutans <i>Capsicum annuum</i> Ser13Term TCA-TGA	CGCGTCCGATAAAAAAATCAAGAATGGCGATTTCATATCTGCTAT GAGTTTTCGAAGTTGAGTTTCTTTCATATTCAGCATTTTTGTGCA ATTCCAAGAACCCATTTGTTGAATTC	5569
		GAATTCAAACAAAATGGGTTCTTGGGAATTGCACAAAATGCTGAAT ATGAAGAAGAACTCAAGTTCGAAACTCATAGCAGATATGGAAAT CGCCATTCTTGATTTTTTATCGGACGCG	5570
		TCGAAGTTGAGTTTCTT	5571
		AAGAACTCAAGTTCGA	5572
15	White leaves Immutans <i>Capsicum annuum</i> Ser17Term TCA-TGA	AAAAATCAAGAATGGCGATTTCATATCTGCTATGAGTTTTCGAACT TCAGTTTCTTCTTGATATTCAGCATTTTTGTGCAATCCAAGAACCC ATTTGTTGAATTCTCTATTTTCACT	5573
		AGTGAAAATAGAGAATTCAAACAAAATGGGTTCTTGGGAATTGCACA AAAATGCTGAATATCAAGAAGAACTGAAGTTCGAAACTCATAGC AGATATGGAAATCGCCATTCTTGATTTTT	5574
		TTCTTCTTGATATTCAG	5575
		CTGAATATCAAGAAGAA	5576
20	White leaves Immutans <i>Capsicum annuum</i> Ser19Term TCA-TGA	CAAGAATGGCGATTTCATATCTGCTATGAGTTTTCGAACTTCAGT TTCTTCTTCATATTGAGCATTTTTGTGCAATCCAAGAACCCATTTT GTTTGAATTCTCTATTTTCACTTAGGAA	5577
		TTCTTAAGTGAAAATAGAGAATTCAAACAAAATGGGTTCTTGGGAATT GCACAAAATGCTCAATATGAAGAAGAACTGAAGTTCGAAACTC ATAGCAGATATGGAAATCGCCATTCTTG	5578
		TTTCATATTGAGCATTTT	5579
		AAAATGCTCAATATGAA	5580
25	White leaves Immutans <i>Capsicum annuum</i> Leu21Term TTG-TAG	CGATTTCCATATCTGCTATGAGTTTTCGAACTTCAGTTTCTTCTTCA TATTCAGCATTTTAGTGCAATCCAAGAACCCATTTTGTGTTGAATTC TCTATTTTCACTTAGGAATTCTCATAG	5581
		CTATGAGAATTCTAAGTGAAAATAGAGAATTCAAACAAAATGGGTT CTTGGGAATTGCACIAAAATGCTGAATATGAAGAAGAACTGAAGTT CGAAACTCATAGCAGATATGGAAATCG	5582
		AGCATTTTAGTGCAATT	5583
		AATTGCACTIAAAATGCT	5584

5	White leaves Immutans <i>Capsicum annuum</i> Cys22Term TGC-TGA	TTCCATATCTGCTATGAGTTTTCGAACTTCAGTTTCTTCTTCATATT CAGCATTTTTGTGAAATTCCAAGAACCCATTTTGTTTGAATTCTCTA TTTTCACTTAGGAATTCTCATAGAACT	5585
		AGTTCTATGAGAATTCCTAAGTGAAAATAGAGAATTCAAACAAATG GGTTCTTGGAATTTCACAAAAATGCTGAATATGAAGAAGAACTGA AGTTCGAAAACTCATAGCAGATATGGAA	5586
		TTTTGTGAAATTCCTAA	5587
		TTGGAATTTCACAAAAA	5588
10	White leaves Immutans <i>Oryza sativa</i> Glu22Term GAG-TAG	TTCGGCAGCAGGGGAGAAGGAGCAGACCGAGGTGGCCGTCGAGG AGTCCTTCCCCTTCAGGTAGACGGCTCCTCCTGACGAGCCACTGG TCACCGCCGAGGAGAGCTGGGTGGTTAAGCTCG	5589
		CGAGCTTAACCAACCCAGCTCTCCTCGGCGGTGACCACTGGCTCG TCAGGAGGAGCCGTCTACCTGAAGGGGAAGGACTCCTCGACGGC CACCTCGGTCTGCTCCTTCTCCCTCGTGCCGAA	5590
		CCTTCAGGTAGACGGCT	5591
		AGCCGTCTACCTGAAGG	5592
15	White leaves Immutans <i>Oryza sativa</i> Glu28Term CAG-TAG	GAGCAGACCGAGGTGGCCGTCGAGGAGTCCTTCCCCTTCAGGGA GACGGCTCCTCCTGACTAGCCACTGGTCACCGCCGAGGAGAGCT GGGTGGTTAAGCTCGAGCAGTCCGTGAACATTT	5593
		AAATGTTACGGACTGCTCGAGCTTAACCAACCCAGCTCTCCTCGG CGGTGACCACTGGCTAGTCAGGAGGAGCCGTCTCCCTGAAGGGG AAGGACTCCTCGACGGCCACCTCGGTCTGCTC	5594
		CTCCTGACTAGCCACTG	5595
		CAGTGGCTAGTCAGGAG	5596
20	White leaves Immutans <i>Oryza sativa</i> Glu34Term GAG-TAG	GTCGAGGAGTCCTTCCCCTTCAGGGAGACGGCTCCTCCTGACGA GCCACTGGTCACCGCCTAGGAGAGCTGGGTGGTTAAGCTCGAGC AGTCCGTGAACATTTTCTCACGGAGTCAGTCA	5597
		TGACTGACTCCGTGAGGAAAATGTTACGGACTGCTCGAGCTTAA CCACCCAGCTCTCCTAGGCGGTGACCACTGGCTCGTCAGGAGGA GCCGTCTCCCTGAAGGGGAAGGACTCCTCGAC	5598
		TCACCGCCTAGGAGAGC	5599
		GCTCTCCTAGGCGGTGA	5600
25	White leaves Immutans <i>Oryza sativa</i> Glu35Term GAG-TAG	GAGGAGTCCTTCCCCTTCAGGGAGACGGCTCCTCCTGACGAGCC ACTGGTCACCGCCGAGTAGAGCTGGGTGGTTAAGCTCGAGCAGT CCGTGAACATTTTCTCACGGAGTCAGTCATCA	5601
		TGATGACTGACTCCGTGAGGAAAATGTTACGGACTGCTCGAGCT TAACCAACCCAGCTCTACTCGGCGGTGACCACTGGCTCGTCAGGA GGAGCCGTCTCCCTGAAGGGGAAGGACTCCTC	5602
		CCGCCGAGTAGAGCTGG	5603
		CCAGCTCTACTCGGCGG	5604

5	White leaves Immutans <i>Oryza sativa</i> Trp37Term TGG-TGA	CTTCCCCTTCAGGGAGACGGCTCCTCCTGACGAGCCACTGGTCAC	5605
		CGCCGAGGAGAGCTGAGTGGTTAAGCTCGAGCAGTCCGTGAACA	
		TTTTCTCACGGAGTCAGTCATCACGATACTT	
		AAGTATCGTGATGACTGACTCCGTGAGGAAAATGTTACGGACTG	5606
10	White leaves Immutans <i>Triticum aestivum</i> Trp22Term TGG-TGA	CTCGAGCTTAACCACTCAGCTCTCCTCGGCGGTGACCACTGGCTC	
		GTCAGGAGGAGCCGTCTCCCTGAAGGGAAG	
		GAGAGCTGAGTGGTTAA	5607
		TTAACCACTCAGCTCTC	5608
15	White leaves Immutans <i>Triticum aestivum</i> Arg25Term AGA-TGA	TCCGGAGGAGGAAGGGGGATTGACGAGGAGCTCACCTCGCCG	5609
		GCGAGGACGGCGACTGAGTCGTGAGATTGAGCAGTCCTTCAAC	
		GTATTCCTCACGATACTGTCATCTTTATACTC	
		GAGTATAAAGATGACAGTATCCGTGAGGAATACGTTGAAGGACTG	5610
20	White leaves Immutans <i>Triticum aestivum</i> Glu27Term GAG-TAG	CTCGAATCTGACGACTCAGTCGCCGTCTCGCCGGCGAGGGTGA	
		GCTCCTCGTCTGAATCCCCCTTCTCCTCCGGA	
		GGCGACTGAGTCGTCAG	5611
		CTGACGACTCAGTCGCC	5612
25	White leaves Immutans <i>Triticum aestivum</i> Gln28Term CAG-TAG	GAGGAAGGGGGATTGACGAGGAGCTCACCTCGCCGGCGAGG	5613
		ACGGCGACTGGGTGCTCTGATTGAGCAGTCCTTCAACGTATTCC	
		TCACGGATACTGTCATCTTTATACTCGATATTC	
		GAATATCGAGTATAAAGATGACAGTATCCGTGAGGAATACGTTGAA	5614
30	White leaves Immutans <i>Triticum aestivum</i> Glu27Term GAG-TAG	GGACTGCTCGAATCAGACACCCAGTCGCCGTCTCGCCGGCGGA	
		GGGTGAGCTCCTCGTCTGAATCCCCCTTCTC	
		GGGTGCTCTGATTGAG	5615
		CTCGAATCAGACGACCC	5616
35	White leaves Immutans <i>Triticum aestivum</i> Glu27Term GAG-TAG	GGGGGATTGACGAGGAGCTCACCTCGCCGGCGAGGACGGCG	5617
		ACTGGGTGCTCAGATTCTAGCAGTCCTTCAACGTATTCTCACGGA	
		TACTGTCATCTTTATACTCGATATTCTGTATC	
		GATACAGAATATCGAGTATAAAGATGACAGTATCCGTGAGGAATAC	5618
40	White leaves Immutans <i>Triticum aestivum</i> Glu27Term GAG-TAG	GTTGAAGGACTGCTAGAATCTGACGACCCAGTCGCCGTCTCGCC	
		GGCGAGGGTGAGCTCCTCGTCTGAATCCCC	
		TCAGATTCTAGCAGTCC	5619
		GGACTGCTAGAATCTGA	5620
45	White leaves Immutans <i>Triticum aestivum</i> Gln28Term CAG-TAG	GGATTGACGAGGAGCTCACCTCGCCGGCGAGGACGGCGACTG	5621
		GGTCGTGAGATTGAGTAGTCCTTCAACGTATTCTCACGGATACT	
		GTCATCTTTATACTCGATATTCTGTATCGTG	
		CACGATACAGAATATCGAGTATAAAGATGACAGTATCCGTGAGGAA	5622
50	White leaves Immutans <i>Triticum aestivum</i> Gln28Term CAG-TAG	TACGTTGAAGGACTACTCGAATCTGACGACCCAGTCGCCGTCTC	
		GCCGGCGAGGGTGAGCTCCTCGTCTGAATCC	
		GATTCGAGTAGTCCTTC	5623
		GAAGGACTACTCGAATC	5624

5

White leaves Immutans <i>Triticum aestivum</i> Tyr46Term TAT-TAG	CGAGCAGTCCTTCAACGTATTCCTCACGGATACTGTCATCTTTATA CTCGATATTCTGTAGCGTGACCGCGACTACGCAAGGTTCTTCGTG CTCGAGACCATCGCCAGGGTGCCCTATTTT	5625
	GAAATAGGGCACCCCTGGCGATGGTCTCGAGCACGAAGAACCTTG CGTAGTCGCGGTACGCTACAGAATATCGAGTATAAAGATGACAG TATCCGTGAGGAATACGTTGAAGGACTGCTCG	5626
	ATTCTGTAGCGTGACCG	5627
	CGGTCACGCTACAGAAT	5628

Example 9**Altering amino acid content of plants**

Another aim of biotechnology is to generate plants, especially crop plants, with added value traits. An example of such a trait is improved nutritional quality in food crops. For example, lysine, tryptophan and threonine, which are essential amino acids in the diet of humans and many animals, are limiting nutrients in most cereal crops. Consequently, grain-based diets, such as those based on corn, barley, wheat, rice, maize, millet, sorghum, and the like, must be supplemented with more expensive synthetic amino acids or amino-acid-containing oilseed protein meals. Increasing the lysine content of these grains or of any of the feed component crops would result in significant added value.

Naturally occurring mutants of plants that have different levels of particular essential amino acids have been identified. However, these mutants are generally not the result of increased free amino acid, but are instead the result of shifts in the overall protein profile of the grain. For example, in maize, reduced levels of lysine-deficient endosperm proteins (prolamines) are complemented by elevated levels of more lysine-rich proteins (albumins, globulins and glutelins). While nutritionally superior, these mutants are associated with reduced yields and poor grain quality, limiting their agronomic usefulness.

An alternative approach is to generate plants with mutations that render key amino acid biosynthetic enzymes insensitive to feedback inhibition. Many such mutations are known and mutation results in increased free amino acid. The increased production can optionally be coupled to increased expression of an abundant storage protein comprising the chosen amino acid. Alternatively, a normally abundant protein can be engineered to contain more of the target amino acid.

The attached table discloses exemplary oligonucleotide base sequences which can be used to generate site-specific mutations that remove feedback inhibition in plant amino acid biosynthetic enzymes.

Table 19
Genome-Altering Oligos Conferring Amino Acid Overproduction

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 10 Met Overproduction CGS <i>Arabidopsis thaliana</i> Arg77His CGT-CAT	TATCCTCCAGGATCTTAAGATTTCTCCTAATTTCTGCCGTGAGCT GAGCATTAAAGCCCATAGAACTGTAGCAACATCGGTGTTGCACA GATCGTGGCGGCTAAGTGGTCCAACAACCC	5629
	GGGTTGTTGGACCACTTAGCCGCCACGATCTGTGCAACACCGAT GTTGCTACAGTTTCTATGGGCTTTAATGCTCAGCTGACGGACGAA ATTAGGAGGAAATCTTAAGATCCTGGAGGATA	5630
	TAAAGCCCATAGAACT	5631
	AGTTTCTATGGGCTTTA	5632
15 Met Overproduction CGS <i>Arabidopsis thaliana</i> Ser81Asn AGC-AAC	TCTTAAGATTTCTCCTAATTTCTGCCGTGAGCTGAGCATTAAAGC CCGTAGAACTGTAAACAACATCGGTGTTGCACAGATCGTGGCGG CTAAGTGGTCCAACAACCCATCCTCCGCGTT	5633
	AACGCGGAGGATGGGTTGTTGGACCACTTAGCCGCCACGATCTG TGCAACACCGATGTTGTACAGTTTCTACGGGCTTTAATGCTCAGC TGACGGACGAAATTAGGAGGAAATCTTAAGA	5634
	AAACTGTAAACAACATCG	5635
	CGATGTTGTACAGTTT	5636
20 Met Overproduction CGS <i>Arabidopsis thaliana</i> Gly84Ser GGT-AGT	TTTCCTCCTAATTTCTGCCGTGAGCTGAGCATTAAAGCCCGTAGAA ACTGTAGCAACATCAGTGTGACAGATCGTGGCGGCTAAGTGGT CCAACAACCCATCCTCCGCGTTACCTTCGG	5637
	CCGAAGGTAACGCGGAGGATGGGTTGTTGGACCACTTAGCCGCC ACGATCTGTGCAACACTGATGTTGCTACAGTTTCTACGGGCTTTAA TGCTCAGCTGACGGACGAAATTAGGAGGAAA	5638
	GCAACATCAGTGTGCA	5639
	TGCAACACIGATGTTGC	5640
25 Met Overproduction CGS <i>Arabidopsis thaliana</i> Gly84Asp GGT-GAT	TTCCTCCTAATTTCTGCCGTGAGCTGAGCATTAAAGCCCGTAGAAA CTGTAGCAACATCGATGTTGACAGATCGTGGCGGCTAAGTGGTC CAACAACCCATCCTCCGCGTTACCTTCGGC	5641
	GCCGAAGGTAACGCGGAGGATGGGTTGTTGGACCACTTAGCCGC CAGATCTGTGCAACATCGATGTTGCTACAGTTTCTACGGGCTTTA ATGCTCAGCTGACGGACGAAATTAGGAGGAA	5642
	CAACATCGATGTTGCAC	5643
	GTGCAACATCGATGTTG	5644

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Met Overproduction CGS <i>Fragaria vesca</i> Arg73His CGC-CAC	TATCGTCACTCATCCTCCGCTTCCCTCCCAACTTCGTCCGCCAGC TCAGCACCAAGGCCCACCGCAACTGCAGCAACATCGGCGTCGCG CAGATCGTCGCGGCTTCGTGGTCCAACAAAGA	5645
	TCTTTGTTGGACCACGAAGCCGCGACGATCTGCGCGACGCCGAT GTTGCTGCAGTTGCGGTGGGCCTTGGTGCTGAGCTGGCGGACGA AGTTGGGAGGGAAGCGGAGGATGAGTGACGATA	5646
	CAAGGCCCACCGCAACT	5647
	AGTTGCGGTGGGCCTTG	5648
10 Met Overproduction CGS <i>Fragaria vesca</i> Ser77Asn AGC-AAC	TCCTCCGCTTCCCTCCCAACTTCGTCCGCCAGCTCAGCACCAAG GCCCCCGCAACTGCAACAACATCGGCGTCGCGCAGATCGTCGC GGCTTCGTGGTCCAACAAAGACTCCGACCTTTC	5649
	GAAAGGTCGGAGTCTTTGTTGGACCACGAAGCCGCGACGATCTG CGCGACGCCGATGTTGTTGCAGTTGCGGCGGGCCTTGGTGCTGA GCTGGCGGACGAAGTTGGGAGGGAAGCGGAGGA	5650
	CAACTGCAACAACATCG	5651
	CGATGTTGTTGCAGTTG	5652
15 Met Overproduction CGS <i>Fragaria vesca</i> Gly80Ser GGC-AGC	TTCCCTCCCAACTTCGTCCGCCAGCTCAGCACCAAGGCCCGCCG CAACTGCAGCAACATCAGCGTCGCGCAGATCGTCGCGGCTTCGT GGTCCAACAAAGACTCCGACCTTTCGGCGGTGC	5653
	GCACCGCCGAAAGGTCGGAGTCTTTGTTGGACCACGAAGCCGCG ACGATCTGCGCGACGCTGATGTTGCTGCAGTTGCGGCGGGCCTT GGTGCTGAGCTGGCGGACGAAGTTGGGAGGGAA	5654
	GCAACATCAGCGTCGCG	5655
	CGCGACGCTGATGTTGC	5656
20 Met Overproduction CGS <i>Fragaria vesca</i> Gly80Asp GGC-GAC	TCCCTCCCAACTTCGTCCGCCAGCTCAGCACCAAGGCCCGCCGC AACTGCAGCAACATCAGCGTCGCGCAGATCGTCGCGGCTTCGTG GTCCAACAAAGACTCCGACCTTTCGGCGGTGCC	5657
	GGCACCGCCGAAAGGTCGGAGTCTTTGTTGGACCACGAAGCCGC GACGATCTGCGCGACGTCGATGTTGCTGCAGTTGCGGCGGGCCT TGGTGCTGAGCTGGCGGACGAAGTTGGGAGGGAA	5658
	CAACATCAGCGTCGCGC	5659
	GCGCGACGTCGATGTTG	5660
25 Met Overproduction CGS <i>Glycine max</i> Arg68His CGC-CAC	TCTCCTCCCTCATCCTCCGCTTCCCTCCCAACTTCAGCGCCAGC TAAGCACCAAGGCGAGCCGCAACTGCAGCAACATCGGCGTCGCG CAAATCGTCGCCGCTTCGTGGTGAACAACAG	5661
	CTGTTGTTCCAGCACGAAGCGGCGACGATTTGCGCGACGCCGAT GTTGCTGCAGTTGCGGCTCGCCTTGGTGCTTAGCTGGCGCTGGA AGTTGGGAGGGAAGCGGAGGATGAGGGAGGAGA	5662
	CCAAGGCGAGCCGCAAC	5663

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GTTGCGGCTCGCCTTGG	5664
5 Met Overproduction CGS <i>Glycine max</i> Ser72Asn AGC-AAC	TCCTCCGCTTCCCTCCCAACTTCCAGCGCCAGCTAAGCACCAAG GCGCGCCGCAACTGCAACAACATCGGCGTCGCGCAAATCGTCGC CGCTTCGTGGTTCGAACAACAGCGACAACCTCTCC	5665
	GGAGAGTTGTCGCTGTTGTTTCGACCACGAAGCGGCGACGATTTG CGCGACGCCGATGTTGTTGCAGTTGCGGCGCGCCTTGGTGCTTA GCTGGCGCTGGAAGTTGGGAGGGAAGCGGAGGA	5666
	CAACTGCAACAACATCG	5667
	CGATGTTGTTGCAGTTG	5668
10 Met Overproduction CGS <i>Glycine max</i> Gly75Ser GGC-AGC	TTCCCTCCCAACTTCCAGCGCCAGCTAAGCACCAAGGCGCGCCG CAACTGCAGCAACATCAGCGTCGCGCAAATCGTCGCCGCTTCGT GGTCGAACAACAGCGACAACCTCTCCGGCCGCCG	5669
	CGGCGGCCGGAGAGTTGTCGCTGTTGTTTCGACCACGAAGCGGC GACGATTTGCGCGACGCTGATGTTGCTGCAGTTGCGGCGCGCCT TGGTGCTTAGCTGGCGCTGGAAGTTGGGAGGGAA	5670
	GCAACATCAGCGTCGCG	5671
	CGCGACGCTGATGTTGC	5672
15 Met Overproduction CGS <i>Glycine max</i> Gly75Asp GGC-GAC	TCCCTCCCAACTTCCAGCGCCAGCTAAGCACCAAGGCGCGCCGC AACTGCAGCAACATCAGCGTCGCGCAAATCGTCGCCGCTTCGTG GTCGAACAACAGCGACAACCTCTCCGGCCGCCG	5673
	CCGGCGGCCGGAGAGTTGTCGCTGTTGTTTCGACCACGAAGCGGC GACGATTTGCGCGACGCTGATGTTGCTGCAGTTGCGGCGCGCCT TGGTGCTTAGCTGGCGCTGGAAGTTGGGAGGGA	5674
	CAACATCGACGTCGCGC	5675
	GCGCGACGCTGATGTTG	5676
20 Met Overproduction CGS <i>Solanum tuberosum</i> Arg70His AGG-CAC	TGTCTTCTCTGATTTTCAGGTTTCCTCCTAATTTCTGAGGCAGCT AAGCATTAAAGGCTCACAGGAATTGCAGCAATATTGGCGTGGCTCA AGTTGTGGCGGCTTCTGGTCTAACAACCA	5677
	TGGTTGTTAGACCAGGAAGCCGCCACAACCTGAGCCACGCCAATA TTGCTGCAATTCCTGTGAGCCTTAATGCTTAGCTGCCTCACGAAAT TAGGAGGAAACCTGAAAATCAGAGAAGACA	5678
	TAAGGCTCACAGGAATT	5679
	AATTCCTGTGAGCCTTA	5680
25 Met Overproduction CGS <i>Solanum tuberosum</i> Ser74Asn AGC-AAC	TTTTCAGGTTTCCTCCTAATTTCTGAGGCAGCTAAGCATTAAAGGC TAGGAGGAATTGCAACAATATTGGCGTGGCTCAAGTTGTGGCGG CTTCCTGGTCTAACAACCAAGCCGGTCCTGA	5681
	TCAGGACCGGCTTGGTTGTTAGACCAGGAAGCCGCCACAACCTG AGCCACGCCAATATTGTTGCAATTCCTCCTAGCCTTAATGCTTAGC TGCCTCACGAAATTAGGAGGAAACCTGAAAA	5682

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GAATTGCAACAATATTG	5683
	CAATATTGTTGCAATTC	5684
5 Met Overproduction CGS <i>Solanum tuberosum</i> Gly77Ser GGC-AGC	TTCCTCCTAATTTCTGTAGGCAGCTAAGCATTAAAGGCTAGGAGG AATTGCAGCAATATTAGCGTGGCTCAAGTTGTGGCGGCTTCCTGG TCTAACAACCAAGCCGGTCTGAATTCCTC	5685
	GAGTGAATTCAGGACCGGCTTGGTTGTTAGACCAGGAAGCCGCC ACAACCTTGAGCCACGCTAATATTGCTGCAATTCCTCCTAGCCTTAA TGCTTAGCTGCCTCACGAAATTAGGAGGAAA	5686
	GCAATATTAGCGTGGCT	5687
	AGCCACGCTAATATTGC	5688
10 Met Overproduction CGS <i>Solanum tuberosum</i> Gly77Asp GGC-GAC	TTCCTCCTAATTTCTGTAGGCAGCTAAGCATTAAAGGCTAGGAGGA ATTGCAGCAATATTAGCGTGGCTCAAGTTGTGGCGGCTTCCTGGT CTAACAACCAAGCCGGTCTGAATTCCTC	5689
	GGAGTGAATTCAGGACCGGCTTGGTTGTTAGACCAGGAAGCCGC CACAACCTTGAGCCACGCTAATATTGCTGCAATTCCTCCTAGCCTTA ATGCTTAGCTGCCTCACGAAATTAGGAGGAA	5690
	CAATATTGACGTGGCTC	5691
	GAGCCACGCTAATATTG	5692
15 Met Overproduction CGS <i>Mesembryanthemum crystallinum</i> Arg73His CGC-CAC	CTTCCTCTCTTATCCTTCGCTTTCCTCCCACTTTGTCCGTCAGCT CAGCACCAAGGCTCGCCACAACCTGCAGCAACATTGGTGTGCGAC AGGTCGTCGCTGCCTCCTGGTCCAACAACCTC	5693
	GAGTTGTTGGACCAGGAGGCAGCGACGACCTGTGCGACACCAAT GTTGCTGCAGTTGTGGCGAGCCTTGGTGTGAGCTGACGGACAA AGTTGGGAGGAAAGCGAAGGATAAGAGAGGAAG	5694
	GGCTCGCCACAACCTGCA	5695
	TGCAGTTGTGGCGAGCC	5696
20 Met Overproduction CGS <i>Mesembryanthemum crystallinum</i> Ser77Asn AGC-AAC	TCCTTCGCTTTCCTCCCACTTTGTCCGTCAGCTCAGCACCAAGG CTCGCCGCAACTGCAACAACATTGGTGTGCGACAGGTCGTGCT GCCTCCTGGTCCAACAACCTCCGATGCCGGCGC	5697
	GCGCCGGCATCGGAGTTGTTGGACCAGGAGGCAGCGACGACCT GTGCGACACCAATGTTGTGAGTTGCGGCGAGCCTTGGTGCTG AGCTGACGGACAAAGTTGGGAGGAAAGCGAAGGA	5698
	CAACTGCAACAACATTG	5699
	CAATGTTGTTGCAAGTTG	5700

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Met Overproduction CGS <i>Mesembryanthemum crystallinum</i> Gly80Ser GGT-AGT	TTTCCTCCCAACTTTGTCCGTCAGCTCAGCACCAAGGCTCGCCGC AACTGCAGCAACATTAGTGTGCGACAGGTCGTGCTGCCTCCTG GTCCAACAACCTCCGATGCCGGCGCCACCTCTT	5701
	AAGAGGTGGCGCCGGCATCGGAGTTGTTGGACCAGGAGGCAGC GACGACCTGTGCGACACTAATGTTGCTGCAGTTGCGGCGAGCCT TGGTGCTGAGCTGACGGACAAAGTTGGGAGGAAA	5702
	GCAACATTAGTGTGCGCA	5703
	TGCGACACTAATGTTGC	5704
10 Met Overproduction CGS <i>Mesembryanthemum crystallinum</i> Gly80Asp GGT-GAT	TTCCTCCCAACTTTGTCCGTCAGCTCAGCACCAAGGCTCGCCGCA ACTGCAGCAACATTGATGTGCGACAGGTCGTGCTGCCTCCTGG TCCAACAACCTCCGATGCCGGCGCCACCTCTTG	5705
	CAAGAGGTGGCGCCGGCATCGGAGTTGTTGGACCAGGAGGCAG CGACGACCTGTGCGACATCAATGTTGCTGCAGTTGCGGCGAGCC TTGGTGCTGAGCTGACGGACAAAGTTGGGAGGAA	5706
	CAACATTGATGTGCGAC	5707
	GTGCGACATCAATGTTG	5708
15 Met Overproduction CGS <i>Zea mays</i> Arg41His CGC-CAC	CCTCTGCTACCATCCTCCGCTTTCCGCCAAACTTTGTCCGCCAGC TTAGCACCAAGGCACACCGCAACTGCAGCAACATCGGCGTCGCG CAGATCGTCGCCGCCGCGTGGTCCGACTGCCC	5709
	GGGCAGTCGGACCACGCGGCGGCGACGATCTGCGCGACGCCGA TGTTGCTGCAGTTGCGGTGTGCCTTGGTGCTAAGCTGGCGGACA AAGTTTGGCGGAAAGCGGAGGATGGTAGCAGAGG	5710
	CAAGGCACACCGCAACT	5711
	AGTTGCGGTGTGCCTTG	5712
20 Met Overproduction CGS <i>Zea mays</i> Ser45Asn AGC-AAC	TCCTCCGCTTTCCGCCAAACTTTGTCCGCCAGCTTAGCACCAAGG CACGCCGCAACTGCAACAACATCGGCGTCGCGCAGATCGTCGCC GCCGCGTGGTCCGACTGCCCCGCCGCTCGCCC	5713
	GGGCGAGCGGCGGGGCGAGTCGGACCACGCGGCGGCGACGATC TGCGCGACGCCGATGTTGTGTCAGTTGCGGCGTGCTTGGTGCT AAGCTGGCGGACAAAGTTTGGCGGAAAGCGGAGGA	5714
	CAACTGCAACAACATCG	5715
	CGATGTTGTGTCAGTTG	5716
25 Met Overproduction CGS <i>Zea mays</i> Gly48Ser GGC-AGC	TTTCGCCAAACTTTGTCCGCCAGCTTAGCACCAAGGCACGCCGC AACTGCAGCAACATCAGCGTCGCGCAGATCGTCGCCGCCGCGTG GTCCGACTGCCCCGCCGCTCGCCCCACTTAG	5717
	CTAAGTGGGGGCGAGCGGCGGGGCGAGTCGGACCACGCGGCGG CGACGATCTGCGCGACGCTGATGTTGCTGCAGTTGCGGCGTGCC TTGGTGCTAAGCTGGCGGACAAAGTTTGGCGGAAA	5718
	GCAACATCAGCGTCGCG	5719

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CGCGACGCTGATGTTGC	5720
Met Overproduction CGS <i>Zea mays</i> Gly48Asp GGC-GAC	TTCCGCCAAACTTTGTCCGCCAGCTTAGCACCAAGGCACGCCGC AACTGCAGCAACATCGACGTGCGCGAGATCGTCGCCGCCGCGTG GTCCGACTGCCCCGCCGCTCGCCCCCACTTAGG	5721
	CCTAAGTGGGGGCGAGCGGCGGGGCAGTCGGACCACGCGGCG GCGACGATCTGCGCGACGTCGATGTTGCTGCAGTTGCGGCGTGC CTTGGTGCTAAGCTGGCGGACAAAGTTTGGCGGAA	5722
	CAACATCGACGTGCGCG	5723
	GCGCGACGTCGATGTTG	5724
Met Overproduction TS <i>Arabidopsis thaliana</i> Leu205Arg CTT-CGT	GTATGAATGATCTGTGGGTGAAACACTGTGGGATTAGTCATACAG GAAGTTTCAAGGATCGTGAATGACTGTTTTGGTTAGTCAAGTTAA TCGTCTGAGAAAGATGAAACGACCTGTGGT	5725
	ACCACAGGTCGTTTCATCTTTCTCAGACGATTAACCTGACTAACCA AAACAGTCATTCCACGATCCTTGAAACTTCCTGTATGACTAATCCC ACAGTGTTTCACCCACAGATCATTCATAC	5726
	CAAGGATCGTGAATGA	5727
	TCATTCCACGATCCTTG	5728
Met Overproduction TS <i>Solanum tuberosum</i> Leu198Arg CTT-CGT	GCATGACTGATTTGTGGGTCAAACACTGTGGGATTAGCCATACTG GTAGTTTTAAGGATCGTGGGATGACTGTTTTGGTGAGTCAAGTTAA TCGCTTGCGGAAAATGCATAAACCGGTTGT	5729
	ACAACCGGTTTATGCATTTTCCGCAAGCGATTAACCTGACTCACCA AAACAGTCATCCACGATCCTTAAACTACCAGTATGGCTAATCCC ACAGTGTTTGACCCACAAATCAGTCATGC	5730
	TAAGGATCGTGGGATGA	5731
	TCATCCACGATCCTTA	5732
Lys Overproduction DHPS <i>Zea mays</i> Ser157Asn AGC-AAC	TCATTGGGCACACAGTGAACCTGCTTTGGCTCTAGAATCAAAGTGA TAGGCAACACAGGAAACAACCTCAACCAGAGAAGCCGTCCACGCA ACAGAACAGGGATTTGCTGTTGGCATGCATGC	5733
	GCATGCATGCCAACAGCAAATCCCTGTTCTGTTGCGTGACGGCT TCTCTGGTTGAGTTGTTTCTCTGTGTTGCCTATCACTTTGATTCTAG AGCCAAAGCAGTTCACTGTGTGCCCAATGA	5734
	CACAGGAAACAACCTCA	5735
	TTGAGTTGTTTCTGTG	5736
Lys Overproduction DHPS <i>Zea mays</i> Ala166Val GCA-GAA	GCTCTAGAATCAAAGTGATAGGCAACACAGGAAGCAACTCAACCA GAGAAGCCGTCCACGAAACAGAACAGGGATTTGCTGTTGGCATG CATGCGGCTCTCCACATCAATCCTTACTACGG	5737
	CCGTAGTAAGGATTGATGTGGAGAGCCGCATGCATGCCAACAGC AAATCCCTGTTCTGTTTCGTGGACGGCTTCTCTGGTTGAGTTGCTT CCTGTGTTGCCTATCACTTTGATTCTAGAGC	5738

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CGTCCACGAAACAGAAC	5739
	GTTCTGTTTCGTGGACG	5740
Lys Overproduction DHPS <i>Zea mays</i> Ala166Thr GCA-ACA	GGCTCTAGAATCAAAGTGATAGGCAACACAGGAAGCAACTCAACC AGAGAAGCCGTCCACACAACAGAACAGGGATTGCTGTTGGCAT GCATGCGGCTCTCCACATCAATCCTTACTACG	5741
	CGTAGTAAGGATTGATGTGGAGAGCCGCATGCATGCCAACAGCAA ATCCCTGTTCTGTTGTGTGGACGGCTTCTCTGGTTGAGTTGCTTC CTGTGTTGCCTATCACTTTGATTCTAGAGCC	5742
	CCGTCCACACAACAGAA	5743
	TTCTGTTGTGTGGACGG	5744
Lys Overproduction DHPS <i>Oryza sativa</i> Ser124Asn AGT-AAT	TTATTGGGCATACAGTTAACTGCTTTGGCACTAAAATTAAAGTGGT CGGCAACACAGGAAATAACTCAACAAGGGAGGCTATTCACGCAAC TGAGCAGGGATTGCTGTAGGTATGCACGC	5745
	GCGTGCATACCTACAGCGAATCCCTGCTCAGTTGCGTGAATAGCC TCCCTTGTTGAGTTATTTCTGTGTTGCCGACCACTTTAATTTAGT GCCAAAGCAGTTAACTGTATGCCCAATAA	5746
	CACAGGAAATAACTCAA	5747
	TTGAGTTATTTCTGTG	5748
Lys Overproduction DHPS <i>Oryza sativa</i> Ala133Val GCA-GTA	GCACTAAAATTAAAGTGGTCGGCAACACAGGAAGTAACTCAACAA GGGAGGCTATTCACGTAAGTGAAGCAGGGATTGCTGTAGGTATG CACGCGGCTCTCCACATCAATCCTTACTACGG	5749
	CCGTAGTAAGGATTGATGTGGAGAGCCGCGTGCATACCTACAGC GAATCCCTGCTCAGTTACGTGAATAGCCTCCCTTGTTGAGTTACTT CCTGTGTTGCCGACCACTTTAATTTAGTGC	5750
	TATTCACGTAAGTGAAG	5751
	GCTCAGTTACGTGAATA	5752
Lys Overproduction DHPS <i>Oryza sativa</i> Ala133Thr GCA-ACA	GGCACTAAAATTAAAGTGGTCGGCAACACAGGAAGTAACTCAACA AGGGAGGCTATTCACACAAGTGAAGCAGGGATTGCTGTAGGTAT GCACGCGGCTCTCCACATCAATCCTTACTACG	5753
	CGTAGTAAGGATTGATGTGGAGAGCCGCGTGCATACCTACAGCG AATCCCTGCTCAGTTGTGTGAATAGCCTCCCTTGTTGAGTTACTTC CTGTGTTGCCGACCACTTTAATTTAGTGC	5754
	CTATTCACAACAAGTGAAG	5755
	CTCAGTTGTGTGAATAG	5756
Lys Overproduction DHPS 1 <i>Triticum aestivum</i> Ser165Asn AGT-AAT	TCATCGGGCATACTGTTAACTGCTTTGGAGCCAACATTAAAGTGAT AGGCAACACGGGAAATAACTCAACCAGAGAAGCTGTTACGCGA CAGAGCAGGGATTGCTGTTGGCATGCATGC	5757

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GCATGCATGCCAACAGCAAATCCCTGCTCTGTCGCGTGAACAGCT TCTCTGGTTGAGTTA <u>TT</u> CCCCGTGTTGCCTATCACTTTAATGTTGG CTCCAAAGCAGTTAACAGTATGCCCGATGA	5758
	CACGGGAA <u>A</u> TAAC TCAA	5759
	TTGAGTTA <u>TT</u> CCCCGTG	5760
Lys Overproduction DHPS 1 <i>Triticum aestivum</i> Ala174Val GCG-GTG	GAGCCAACATTAAAGTGATAGGCAACACGGGAAGTAACTCAACCA GAGAAGCTGTTACG <u>T</u> GACAGAGCAGGGATTTGCTGTTGGCATG CATGCAGCTCTTCATGTCAATCCTTACTACGG	5761
	CCGTAGTAAGGATTGACATGAAGAGCTGCATGCATGCCAACAGCA AATCCCTGCTCTGTC <u>A</u> CGTGAACAGCTTCTCTGGTTGAGTACTT CCCGTGTTGCCTATCACTTTAATGTTGGCTC	5762
	TGTTACG <u>T</u> GACAGAGC	5763
	GCTCTGTC <u>A</u> CGTGAACA	5764
Lys Overproduction DHPS 1 <i>Triticum aestivum</i> Ala174Thr GCG-ACG	GGAGCCAACATTAAAGTGATAGGCAACACGGGAAGTAACTCAACC AGAGAAGCTGTTCA <u>C</u> ACGACAGAGCAGGGATTTGCTGTTGGCAT GCATGCAGCTCTTCATGTCAATCCTTACTACG	5765
	CGTAGTAAGGATTGACATGAAGAGCTGCATGCATGCCAACAGCAA ATCCCTGCTCTGTCG <u>T</u> GTGAACAGCTTCTCTGGTTGAGTACTTC CCGTGTTGCCTATCACTTTAATGTTGGCTCC	5766
	CTGTTCA <u>C</u> ACGACAGAG	5767
	CTCTGTCG <u>T</u> GTGAACAG	5768
Lys Overproduction DHPS 2 <i>Triticum aestivum</i> Ser154Asn AGT-AAT	TCATCGGGCACACTGTTAACTGCTTTGGAACAACTAAAGTGAT AGGCAACACGGGAA <u>A</u> TAAC TCACTAGAGAAGCGATTACGCTTC AGAGCAGGGATTTGCTGTTGGCATGCATGC	5769
	GCATGCATGCCAACAGCAAATCCCTGCTCTGAAGCGTGAATCGCT TCTCTAGTTGAGTTA <u>TT</u> CCCCGTGTTGCCTATCACTTTAATGTTAGT TCCAAAGCAGTTAACAGTGTGCCCGATGA	5770
	CACGGGAA <u>A</u> TAAC TCAA	5771
	TTGAGTTA <u>TT</u> CCCCGTG	5772
Lys Overproduction DHPS 2 <i>Triticum aestivum</i> Ala163Val GCT-GTT	GAACTAACATTAAAGTGATAGGCAACACGGGAAGTAACTCAACTA GAGAAGCGATTACG <u>T</u> TTT CAGAGCAGGGATTTGCTGTTGGCATGC ATGCAGCTCTCCATGTCAATCCTTACTATGG	5773
	CCATAGTAAGGATTGACATGGAGAGCTGCATGCATGCCAACAGCA AATCCCTGCTCTGAA <u>A</u> CGTGAATCGCTTCTCTAGTTGAGTACTTC CCGTGTTGCCTATCACTTTAATGTTAGTTC	5774
	GATTCACG <u>T</u> TT CAGAGC	5775
	GCTCTGAA <u>A</u> CGTGAATC	5776

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Lys Overproduction DHPS 2 <i>Triticum aestivum</i> Ala163Thr GCT-ACT	GGAAC <u>T</u> AACATTAAAGTGATAGGCAACACGGGAAGTAACTCAACT AGAGAAGCGATTACAC <u>A</u> CTTCAGAGCAGGGATTTGCTGTTGGCATG CATGCAGCTCTCCATGTCAATCCTTACTATG	5777
	CATAGTAAGGATTGACATGGAGAGCTGCATGCATGCCAACAGCAA ATCCCTGCTCTGAAG <u>T</u> GTGAATCGCTTCTCTAGTTGAGTTACTTCC CGTGTTGCCTATCACTTTAATGTTAGTTCC	5778
	CGATTCAC <u>A</u> CTTCAGAG	5779
	CTCTGAAG <u>T</u> GTGAATCG	5780
10 Lys Overproduction DHPS <i>Coix lacryma-jobi</i> Ser154Asn AGT-AAT	CTCATTGGGCATACTGTGAAGTCTTTGGCTCTAGAATTAAAGTGA TAGGCAACACAGGAA <u>A</u> TAACTCAACCAGAGAAGCTGTTACGCAA CAGAGCAGGGATTTGCTGTTGGCATGCATG	5781
	CATGCATGCCAACAGCAAATCCCTGCTCTGTTGCGTGAACAGCTT CTCTGGTTGAGTTA <u>T</u> TCCTGTGTTGCCTATCACTTTAATTCTAGA GCCAAAGCAGTTCACAGTATGCCCAATGAG	5782
	CACAGGAA <u>A</u> TAACTCAA	5783
	TTGAGTTA <u>T</u> TCCTGTG	5784
15 Lys Overproduction DHPS <i>Coix lacryma-jobi</i> Ala163Val GCA-GTA	GCTCTAGAATTAAAGTGATAGGCAACACAGGAAGTAACTCAACCA GAGAAGCTGTTACG <u>T</u> AACAGAGCAGGGATTTGCTGTTGGCATGC ATGCAGCTCTCCACATCAATCCTTACTATGG	5785
	CCATAGTAAGGATTGATGTGGAGAGCTGCATGCATGCCAACAGCA AATCCCTGCTCTGTT <u>A</u> CGTGAACAGCTTCTCTGGTTGAGTTACTTC CTGTGTTGCCTATCACTTTAATTCTAGAGC	5786
	TGTTACG <u>T</u> AACAGAGC	5787
	GCTCTGTT <u>A</u> CGTGAACA	5788
20 Lys Overproduction DHPS <i>Coix lacryma-jobi</i> Ala163Thr GCA-ACA	GGCTCTAGAATTAAAGTGATAGGCAACACAGGAAGTAACTCAACC AGAGAAGCTGTTACAC <u>A</u> CAACAGAGCAGGGATTTGCTGTTGGCATG CATGCAGCTCTCCACATCAATCCTTACTATG	5789
	CATAGTAAGGATTGATGTGGAGAGCTGCATGCATGCCAACAGCAA ATCCCTGCTCTGTTG <u>T</u> GTGAACAGCTTCTCTGGTTGAGTTACTTCC TGTGTTGCCTATCACTTTAATTCTAGAGCC	5790
	CTGTTACAC <u>A</u> CAACAGAG	5791
	CTCTGTTG <u>T</u> GTGAACAG	5792
25 Lys Overproduction DHPS <i>Nicotiana tabacum</i> Ser136Asn AGC-AAC	TCATTGGTCACACAGTCAATTGTTTTGGAGGGTCCATCAAAGTCAT CGGGAACACTGGAA <u>A</u> CAACTCCACAAGGGAAGCAATCCATGCAA CTGAACAGGGATTTGCTGTAGGTATGCATGC	5793
	GCATGCATACCTACAGCAAATCCCTGTTCAAGTTGCATGGATTGCTT CCCTTGTGGAGTTG <u>T</u> TTCCAGTGTTCCCGATGACTTTGATGGACC CTCCAAAACAATTGACTGTGTGACCAATGA	5794
	CACTGGAA <u>A</u> CAACTCCA	5795

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGGAGTTGTTCCAGTG	5796
5 Lys Overproduction DHPS <i>Nicotiana tabacum</i> Ala145Val GCA-GTA	GAGGGTCCATCAAAGTCATCGGGAACACTGGAAGCAACTCCACAA GGGAAGCAATCCATGTAAGTGAACAGGGATTGCTGTAGGTATGC ATGCAGCTCTTCACATTAATCCCTACTATGG	5797
	CCATAGTAGGGATTAATGTGAAGAGCTGCATGCATACCTACAGCA AATCCCTGTTCAAGTACATGGATTGCTTCCCTTGTGGAGTTGCTTC CAGTGTTCCCGATGACTTTGATGGACCCTC	5798
	AATCCATGTAAGTGAAC	5799
	GTTCAAGTTACATGGATT	5800
10 Lys Overproduction DHPS <i>Nicotiana tabacum</i> Ala145Thr GCA-ACA	GGAGGGTCCATCAAAGTCATCGGGAACACTGGAAGCAACTCCAC AAGGAAGCAATCCATCAAGTGAACAGGGATTGCTGTAGGTAT GCATGCAGCTCTTCACATTAATCCCTACTATG	5801
	CATAGTAGGGATTAATGTGAAGAGCTGCATGCATACCTACAGCAA ATCCCTGTTCAAGTTATGGATTGCTTCCCTTGTGGAGTTGCTTCC AGTGTTCCCGATGACTTTGATGGACCCTCC	5802
	CAATCCATCAAGTGAAC	5803
	TTCAGTTGATGGATTG	5804
15 Lys Overproduction DHPS <i>Arabidopsis thaliana</i> Ser142Asn AGC-AAC	TTATAGGCCATACCGTTAACTGTTTTGGCGGAAGCATCAAAGTCAT TGGAACACTGGAACAATTCGACTAGAGAAGCAATCCACGCGAC TGAACAAGGATTCGCGGTTGGAATGCATGC	5805
	GCATGCATTCCAACCGCAATCCTTGTTCAAGTCGCGTGGATTGCT TCTCTAGTCGAATTGTTCCAGTGTTCCAATGACTTTGATGCTTC CGCCAAAACAGTTAACGGTATGGCCTATAA	5806
	CACTGGAAACAATTCGA	5807
	TCGAATTGTTCCAGTG	5808
20 Lys Overproduction DHPS <i>Arabidopsis thaliana</i> Ala151Val GCG-GTG	GCGGAAGCATCAAAGTCATTGGAACACTGGAAGCAATTCGACTA GAGAAGCAATCCACGTGACTGAACAAGGATTCGCGGTTGGAATGC ATGCTGCTCTTCATATAAACCCCTACTATGG	5809
	CCATAGTAAGGGTTTATATGAAGAGCAGCATGCATTCCAACCGCG AATCCTTGTTCAAGTACGTGGATTGCTTCTCTAGTCGAATTGCTTC CAGTGTTCCAATGACTTTGATGCTTCCGC	5810
	AATCCACGTGACTGAAC	5811
	GTTCAAGTACGTGGATT	5812
25 Lys Overproduction DHPS <i>Arabidopsis thaliana</i> Ala151Thr GCG-ACG	GGCGGAAGCATCAAAGTCATTGGAACACTGGAAGCAATTCGACT AGAGAAGCAATCCACACGACTGAACAAGGATTCGCGGTTGGAATG CATGCTGCTCTTCATATAAACCCCTACTATG	5813
	CATAGTAAGGGTTTATATGAAGAGCAGCATGCATTCCAACCGCGA ATCCTTGTTCAAGTACGTGGATTGCTTCTCTAGTCGAATTGCTTCC AGTGTTCCAATGACTTTGATGCTTCCGCC	5814

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CAATCCAC <u>A</u> CGACTGAA	5815
	TTCAGTCG <u>T</u> GTGGATTG	5816
Lys Overproduction DHPS <i>Glycine max</i> Ser103Asn AGC-AAC	TTATTGCTCATACAGTCAACTGTTTTGGTGGGAAAATTAAGGTTATT GGAAATACTGGAA <u>A</u> CAACTCCACCAGGGAAGCAATTCATGCCACT GAGCAGGGTTTTGCTGTTGGAATGCATGC	5817
	GCATGCATTCCAACAGCAAAACCCTGCTCAGTGGCATGAATTGCT TCCCTGGTGGAGTTG <u>T</u> TTCCAGTATTTCCAATAACCTTAATTTTCC CACCAAAACAGTTGACTGTATGAGCAATAA	5818
	TACTGGAA <u>A</u> CAACTCCA	5819
	TGGAGTTG <u>T</u> TTCCAGTA	5820
Lys Overproduction DHPS <i>Glycine max</i> Ala112Val GCC-GTC	GTGGGAAAATTAAGGTTATTGGAAATACTGGAAGCAACTCCACCA GGGAAGCAATTCATG <u>T</u> CACTGAGCAGGGTTTTGCTGTTGGAATGC ATGCTGCCCTTCACATAAACCCTTACTATGG	5821
	CCATAGTAAGGGTTTATGTGAAGGGCAGCATGCATTCCAACAGCA AAACCCTGCTCAGTG <u>A</u> CATGAATTGCTTCCCTGGTGGAGTTGCTT CCAGTATTTCCAATAACCTTAATTTTCCCAC	5822
	AATTCATG <u>T</u> CACTGAGC	5823
	GCTCAGTG <u>A</u> CATGAATT	5824
Lys Overproduction DHPS <i>Glycine max</i> Ala112Thr GCC-ACC	GGTGGGAAAATTAAGGTTATTGGAAATACTGGAAGCAACTCCACC AGGGAAGCAATTCAT <u>A</u> CCACTGAGCAGGGTTTTGCTGTTGGAATG CATGCTGCCCTTCACATAAACCCTTACTATG	5825
	CATAGTAAGGGTTTATGTGAAGGGCAGCATGCATTCCAACAGCAA AACCCTGCTCAGTGGTATGAATTGCTTCCCTGGTGGAGTTGCTTC CAGTATTTCCAATAACCTTAATTTTCCCACC	5826
	CAATTCAT <u>A</u> CCACTGAG	5827
	CTCAGTGG <u>T</u> ATGAATTG	5828
Trp Overproduction AS <i>Arabidopsis thaliana</i> Asp341Asn GAC-AAC	CTTGCAGGAGACATATTTAGATCGTGCTGAGTCAACGTTTTGAG CGGCGAACATTTGCA <u>A</u> ACCCCTTTGAAGTTTATAGAGCACTAAGA GTTGTGAATCCAAGTCCGTATATGGGTTATT	5829
	AATAACCCATATACGGACTTGATTCACAACTCTTAGTGCTCTATA AACTTCAAAGGGGT <u>T</u> TGCAAATGTTGCGCGCTCAAACGTTGACT CAGCACGATCTGAAATATGTCTCCTGCAAG	5830
	CATTTGCA <u>A</u> ACCCCTTT	5831
	AAAGGGGT <u>T</u> TGCAAATG	5832
Trp Overproduction AS <i>Nicotiana tabacum</i> Asp326Asn GAC-AAC	GCTGCAGGAGACATATTTCAAATCGTTTTAAGTCAACGCTTTGAGA GAAGAACATTTGCT <u>A</u> ACCCATTTGAAGTGACAGAGCATTAAAGAT TGTGAATCCAAGCCCATATATGACTTACA	5833

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGTAAGTCATATATGGGCTTGGATTCAAAATTCTTAATGCTCTGTA CACTTCAAATGGGT <u>AG</u> CAAATGTTCTTCTCTCAAAGCGTTGACTT AAAACGATTTGAAATATGTCTCCTGCAGC	5834
	CATTTGCT <u>A</u> ACCCATT	5835
	AAATGGGT <u>T</u> AGCAAATG	5836
5 Trp Overproduction AS <i>Oryza sativa</i> Asp323Asn GAC-AAC	CTAGCTGGTGACATTTTTCAAGTAGTCTTAAGCCAGCGTTTTGAGA GGCGTACATTTGCT <u>A</u> ACCCCTTTGAGGTGTACCGTGCATTGCGTA TTGTCAATCCTAGTCCTTATATGGCCTATC	5837
	GATAGGCCATATAAGGACTAGGATTGACAATACGCAATGCACGGT ACACCTCAAAGGGGT <u>AG</u> CAAATGTACGCCTCTCAAACGCTGGC TTAAGACTACTTGAAAAATGTCACCAGCTAG	5838
	CATTTGCT <u>A</u> ACCCCTTT	5839
	AAAGGGGT <u>T</u> AGCAAATG	5840
10 Trp Overproduction AS <i>Ruta graveolens</i> Asp354Asn GAC-AAC	CTTGCTGGTGACATATTCAGATCGTACTAAGTCAGCGTTTTGAAA GGCGAACGTTGCGA <u>A</u> ACCCATTTGAAATCTATAGATCACTGAGGA TTGTTAATCCAAGCCCATATATGACTTATT	5841
	AATAAGTCATATATGGGCTTGGATTAACAATCCTCAGTGATCTATA GATTTCAAATGGGT <u>T</u> GCGAACGTTGCGCTTTCAAACGCTGACTT AGTACGATCTGGAATATGTCACCAGCAAG	5842
	CGTTGCGA <u>A</u> ACCCATT	5843
	AAATGGGT <u>T</u> GCGAACG	5844
15 Trp Overproduction AS <i>Catharanthus roseus</i> Asp354Asn GAT-AAT	CTGGCTGGGGACATATTCAGCTTGTCTAAGTCAGCGTTTTGAA CGGCGAACATTTGCA <u>A</u> ATCCATTTGAAGTCTACCGAGCATTGAGA ATTGTCAACCCAAGTCCATATATGACTTATT	5845
	AATAAGTCATATATGGACTTGGGTTGACAATTCTCAATGCTCGGTA GACTTCAAATGGAT <u>T</u> GCAAATGTTGCGCGTTCAAACGCTGACTT AGGACAAGCTGGAATATGTCCCCAGCCAG	5846
	CATTTGCA <u>A</u> ATCCATT	5847
	AAATGGAT <u>T</u> GCAAATG	5848

Example 10**Production of modified starch in plants**

A principal aim of biotechnology is the improvement of crop plants for food value, agriculture, and to produce a range of plant-derived raw materials. Along with oils, fats and proteins, polysaccharides constitute the main raw materials derived from plants, and apart from cellulose, the storage polymer starch is the most important polysaccharide raw material. Starch is derived from a range of plants, but maize is the most important cultivated plant for the production of starch.

The polysaccharide starch is a polymer made up of glucose molecules. However, starch is not a homogeneous raw material and is, in fact, a highly complex mixture of various types of molecules which differ from each other, for example, in their degree of polymerization and in the degree of branching of the glucose chains. For example, amylose-starch is a basically non-branched polymer made up of α -1,4-glycosidically branched glucose molecules, and amylopectin-starch is a complex mixture of variously branched glucose chains. The branching results from additional α -1,6-glycosidic linkages. In plants from which starch is typically isolated, for example maize or potato, the starch is approximately 25% amylose-starch and 75% amylopectin-starch.

In maize, various mutants in starch metabolism are known, for example *waxy*, *sugary*, *shrunk* and *opaque-2*. In addition to producing a modified starch, these mutations greatly improve grain quality in maize, and thus expand the use of maize not only as the food but also for the important industrial materials in food chemistry. It would therefore be advantageous to be able readily to obtain mutants in these genes in particular maize genotypes as well as other plants. Such plants can be obtained, for example, using traditional breeding methods and through specific genetic modification by means of recombinant DNA techniques.

The attached tables disclose exemplary oligonucleotide base sequences which can be used to generate site-specific mutations in genes involved in starch metabolism.

Table 20
Genome-Altering Oligos Conferring Increased Starch

Phenotype, Gene Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Ala99Lys GCA-AAA	GAACTTGAGACTGAGAAAAGGGATCCAAGGACAGTTGCTTCCATT ATTCTTGGAGGTGGAAAGGAAGCTCGACTCTTCTCTCACAAA CGCCGCGCCAAGCCTGCCGTTCTATCGGGG	5849
	CCCCAGATAGGAACGGCAGGCTTGGCGCGCGCTTTTGTGAGAGGA AAGAGTCGAGTTCTTTCCACCTCCAAGAATAATGGAAGCAACT GTCCTTGGATCCCTTTTCTCAGTCTCAAGTTC	5850
	GAGGTGGAAAGGAAGCT	5851
	AGTTCCTTTCCACCTC	5852
Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Pro127Leu CCA-CTA	CAAAACGCGCGCCAAGCCTGCCGTTCTATCGGGGGAGCCTAT AGGTTGATAGATGTACTAATGAGCAATTGTATTAACAGCGGAATCA ACAAAGTCTACATACTCACACAATATAACTC	5853
	GAGTTATATTGTGTGAGTATGTAGACTTTGTTGATTCCGCTGTAA TACAATTGCTCATTAGTACATCTATCAACCTATAGGCTCCCCCGAT AGGAACGGCAGGCTTGGCGCGCGCTTTTG	5854
	AGATGTACTAATGAGCA	5855
	TGCTCATTAGTACATCT	5856
Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Gly162Asn GGA-AAT	TCACACAATATAACTCAGCATCATTGAACAGGCATTTAGCCCGTGC TTACAACTCCAATAATCTTGGCTTTGGAGATGGCTATGTTGAGGTT CTTGCGGCCACTCAAACGCCAGGAGAATC	5857
	GATTCTCCTGGCGTTTGAGTGGCCGCAAGAACCTCAACATAGCCA TCTCCAAAGCCAAGATTATTGGAGTTGTAAGCACGGGCTAAATGC CTGTTCAATGATGCTGAGTTATATTGTGTGA	5858
	CTCCAATAATCTTGGCT	5859
	AGCCAAGATTATTGGAG	5860
Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Gly162Asn GGA-AAC	TCACACAATATAACTCAGCATCATTGAACAGGCATTTAGCCCGTGC TTACAACTCCAATAACCTTGGCTTTGGAGATGGCTATGTTGAGGTT CTTGCGGCCACTCAAACGCCAGGAGAATC	5861
	GATTCTCCTGGCGTTTGAGTGGCCGCAAGAACCTCAACATAGCCA TCTCCAAAGCCAAGGTTATTGGAGTTGTAAGCACGGGCTAAATGC CTGTTCAATGATGCTGAGTTATATTGTGTGA	5862
	CTCCAATAACCTTGGCT	5863
	AGCCAAGGTTATTGGAG	5864

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Asn100Lys AAT-AAA	GTTTGAGAGAAGAAAGGTAGACCCGCAAAATGTGGCTGCAATCAT TCTAGGAGGAGGCAAAGGAGCTAAACTCTTCCCTCTTACAATGAG AGCCGCAACACCAGCTGTAAATATTCATCTT	5865
	AAGATGAATATTTACAGCTGGTGTTCGGCTCTCATTGTAAGAGG GAAGAGTTTAGCTCCTTTGCCTCCTCCTAGAATGATTGCAGCCAC ATTTTGGGGTCTACCTTTCTTCTCTCAAAC	5866
	GGAGGCAAAGGAGCTAA	5867
	TTAGCTCCTTTGCCTCC	5868
10 Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Pro128Leu CCG-CTG	CTTGTGTCTTCAAATTATGTTAGGTTCCCTGTTGGTGGATGCTACAG GCTGATCGATATCCTIGATGAGTAACTGTATTAACAGCTGCATCAAC AAGATATTTGTGCTGACACAGTTCAACTC	5869
	GAGTTGAAGTGTGTCAGCACAAATATCTTGTGATGCAGCTGTTAA TACAGTTACTCATCAGGATATCGATCAGCCTGTAGCATCCACCAA CAGGAACCTAACATAATTTGAAGACACAAG	5870
	CGATATCCTIGATGAGTA	5871
	TACTCATCAGGATATCG	5872
15 Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Gly163Asn GGC-AAT	TGACACAGTTCAACTCAGCTTCCCTTAATCGACATTTAGCACGAAC TTATTTTGGGAATAATATAAACTTTGGAGGTGGTTTCGTAGAGGTA CAAACACTATGACAATAATAACTCTCAGC	5873
	GCTGAGAGTTATTATTGTCATAGTGTGTTGTACCTCTACGAAACCAC CTCCAAAGTTTATATTATTCCCAAATAAGTTTCGTGCTAAATGTCTG ATTAAGGGAAGCTGAGTTGAAGTGTGTCA	5874
	TGGGAATAATATAAACT	5875
	AGTTTATATTATTCCCA	5876
20 Increased Starch ADPGPP <i>Arabidopsis thaliana</i> Gly163Asn GGC-AAC	TGACACAGTTCAACTCAGCTTCCCTTAATCGACATTTAGCACGAAC TTATTTTGGGAATAACATAAACTTTGGAGGTGGTTTCGTAGAGGTA CAAACACTATGACAATAATAACTCTCAGC	5877
	GCTGAGAGTTATTATTGTCATAGTGTGTTGTACCTCTACGAAACCAC CTCCAAAGTTTATGTTATTCCCAAATAAGTTTCGTGCTAAATGTCTG ATTAAGGGAAGCTGAGTTGAAGTGTGTCA	5878
	TGGGAATAACATAAACT	5879
	AGTTTATGTTATTCCCA	5880
25 Increased Starch ADPGPP <i>Lycopersicon esculentum</i> Val94Lys GTT-AAA	TTGAGGAACAACCAACGGCAGATCCAAAAGCTGTTGCCTCTGTCA TTCTAGGTGGTGGTAAAGGAACTCGTCTTTTTCTCTTACAAGCA GAAGAGCTAAACCAGCTGTTCTTATTGGTGG	5881
	CCACCAATAGGAACAGCTGTTTAGCTCTTCTGCTTGTAAAGAGGA AAAAGACGAGTTCCCTTACCACCACCTAGAATGACAGAGGCAACA GCTTTTGGATCTGCCGTTGGTTGTTCTCTCAA	5882
	TGGTGGTAAAGGAACTC	5883

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GAGTTCCTTTACCACCA	5884
5 Increased Starch ADPGPP <i>Lycopersicon esculentum</i> Pro122Leu CCA-CAA	CAAGCAGAAGAGCTAAACCAGCTGTTCTATTGGTGGTTGTTACC GGCTAATTGATGTACAATGAGTAACTGCATTAAACAGTGGCATAC GGAAAATTTTCATCTTAACACAGTTCAATTC	5885
	GAATTGAAGTGTGTTAAGATGAAAATTTCCGTATGCCACTGTAA TGCAGTTACTCATTGTACATCAATTAGCCGGTAACAACCACCAAT AGGAACAGCTGGTTTAGCTCTTCTGCTTG	5886
	TGATGTACAATGAGTA	5887
	TACTCATTGTACATCA	5888
10 Increased Starch ADPGPP <i>Lycopersicon esculentum</i> Gly158Asn GGA-AAT	CACAGTTCAATTCCTTTCCCTCAATCGTCACCTTGCCCGCACGTA TAATTTTGGAATATGTGGGTTTTGGAGATGGATTTGTGGAGGTT TTAGCTGCAACCCAGACTCCAGGGGATGC	5889
	GCATCCCCTGGAGTCTGGGTTGCAGCTAAAACCTCCACAAATCCA TCTCCAAAACCCACATTATTTCCAAAATTATACGTGCGGGCAAGGT GACGATTGAGGGAAAAGGAATTGAACTGTG	5890
	TGGAAATATGTGGGTT	5891
	AACCCACATTATTTCCA	5892
15 Increased Starch ADPGPP <i>Lycopersicon esculentum</i> Gly158Asn GGA-AAC	CACAGTTCAATTCCTTTCCCTCAATCGTCACCTTGCCCGCACGTA TAATTTTGGAATAACGTGGGTTTTGGAGATGGATTTGTGGAGGTT TTAGCTGCAACCCAGACTCCAGGGGATGC	5893
	GCATCCCCTGGAGTCTGGGTTGCAGCTAAAACCTCCACAAATCCA TCTCCAAAACCCACGTTATTTCCAAAATTATACGTGCGGGCAAGGT GACGATTGAGGGAAAAGGAATTGAACTGTG	5894
	TGGAAATAACGTGGGTT	5895
	AACCCACGTTATTTCCA	5896
20 Increased Starch ADPGPP <i>Cicer arietinum</i> Ala101Lys GCT-AAA	ACGTAGATTTGGAAAAAGAGACCCAAGTACAGTTGTAGCAATTAT ACTAGGTGGAGGTAAGGAACTCGTCTCTTCCCTCTCACCAGC GACGAGCCAAGCCTGCTGTTCCAATTGGAGG	5897
	CCTCCAATTGGAACAGCAGGCTTGGCTCGTCTGGTGAGAGG GAAGAGACGAGTTCTTTACCTCCACCTAGTATAATTGCTACAAC GTACTTGGGTCTCTTTTCCAAATCTACGT	5898
	TGGAGGTAAGGAACTC	5899
	GAGTTCCTTTACCTCCA	5900

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Increased Starch ADPGPP <i>Cicer arietinum</i> Pro129Leu CCA-CTA	CCAAGCGACGAGCCAAGCCTGCTGTTCCAATTGGAGGTGCTTATA GGCTGATAGATGTACTAATGAGTAAGTGCATCAATAGTGGGATCAA CAAAGTATACATTCTCACTCAATTTAATTC	5901
	GAATTAATTTGAGTGAGAATGTATACTTTGTTGATCCCACTATTGAT GCAGTTACTCATTAGTACATCTATCAGCCTATAAGCACCTCCAATT GGAACAGCAGGCTTGGCTCGTCGCTTGG	5902
	AGATGTACTAATGAGTA	5903
	TACTCATTAGTACATCT	5904
10 Increased Starch ADPGPP <i>Cicer arietinum</i> Gly165Asn GGA-AAT	CTCAATTTAATTCAGCCTCACTCAACAGGCATATTGCACGTGCTTA TAACTCTGGTACTAATGTCACCTTTGGAGATGGCTATGTTGAGGTT CTTGCAGCAACTCAAACCTCCAGGGGAGCA	5905
	TGCTCCCCTGGAGTTTGAGTTGCTGCAAGAACCTCAACATAGCCA TCTCCAAAAGTGACATTAGTACCAGAGTTATAAGCACGTGCAATAT GCCTGTTGAGTGAGGCTGAATTAAATTGAG	5906
	TGGTACTAATGTCACCTT	5907
	AAGTGACATTAGTACCA	5908
15 Increased Starch ADPGPP <i>Cicer arietinum</i> Gly165Asn GGA-AAC	CTCAATTTAATTCAGCCTCACTCAACAGGCATATTGCACGTGCTTA TAACTCTGGTACTAACGTCACCTTTGGAGATGGCTATGTTGAGGTT CTTGCAGCAACTCAAACCTCCAGGGGAGCA	5909
	TGCTCCCCTGGAGTTTGAGTTGCTGCAAGAACCTCAACATAGCCA TCTCCAAAAGTGACGTTAGTACCAGAGTTATAAGCACGTGCAATAT GCCTGTTGAGTGAGGCTGAATTAAATTGAG	5910
	TGGTACTAACGTCACCTT	5911
	AAGTGACGTTAGTACCA	5912
20 Increased Starch ADPGPP <i>Ipomoea batatas</i> Ala94Lys GCA-AAA	ATATTGGAGAGGCGTCGGGCAAACCCTAAGAATGTGGCTGCAATC ATACTGCCAGGCGGTAAAGGGACACACCTATTCCCTCTACCAAT CGAGCTGCAACCCCTGCTGTTCCACTTGGAG	5913
	CTCCAAGTGAACAGCAGGGGTTGCAGCTCGATTGGTGAGAGGG AATAGGTGTGTCCCTTTACCGCCTGGCAGTATGATTGCAGCCACA TTCTTAGGGTTTGCCGACGCTCTCCAATAT	5914
	CAGGCGGTAAAGGGACA	5915
	TGTCCTTTACCGCCTG	5916
25 Increased Starch ADPGPP <i>Ipomoea batatas</i> Pro122Leu CCA-CTA	CCAATCGAGCTGCAACCCCTGCTGTTCCACTTGGAGGATGCTATA GGTTGATCGACATTCTAATGAGCAACTGCATCAACAGCGGGGTTA ACAAGATCTTTGTGCTGACCCAGTTCAATTC	5917
	GAATTGAAGTGGGTGAGCACAAGATCTTGTTAACCCCGCTGTTG ATGCAGTTGCTCATTAGAATGTCGATCAACCTATAGCATCCTCCAA GTGGAACAGCAGGGGTTGCAGCTCGATTGG	5918
	CGACATTCTAATGAGCA	5919

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGCTCATT <u>AGA</u> ATGTCCG	5920
5 Increased Starch ADPGPP <i>Ipomoea batatas</i> Gly157Asn GGT-AAT	TGACCCAGTTCAATTCAAGCTTCTCTTAACCGTCACATTTCCCGTAC CGTCTTTGGCAAT <u>AAT</u> GTGAGCTTCGGAGATGGATTTGTTGAGGT GCTGGCTGCAACCCAAACACAAGGGGAAAC	5921
	GTTTCCCCTTGTGTTTGGGTTGCAGCCAGCACCTCAACAAATCCA TCTCCGAAGCTCAC <u>ATT</u> ATTGCCAAAGACGGTACGGGAAATGTGA CGGTTAAGAGAAGCTGAATTGAACTGGGTCA	5922
	TGGCAAT <u>AAT</u> GTGAGCT	5923
	AGCTCAC <u>ATT</u> ATTGCCA	5924
10 Increased Starch ADPGPP <i>Ipomoea batatas</i> Gly157Asn GGT-AAC	TGACCCAGTTCAATTCAAGCTTCTCTTAACCGTCACATTTCCCGTAC CGTCTTTGGCAAT <u>AAC</u> GTGAGCTTCGGAGATGGATTTGTTGAGGT GCTGGCTGCAACCCAAACACAAGGGGAAAC	5925
	GTTTCCCCTTGTGTTTGGGTTGCAGCCAGCACCTCAACAAATCCA TCTCCGAAGCTCAC <u>GTT</u> ATTGCCAAAGACGGTACGGGAAATGTGA CGGTTAAGAGAAGCTGAATTGAACTGGGTCA	5926
	TGGCAAT <u>AAC</u> GTGAGCT	5927
	AGCTCAC <u>GTT</u> ATTGCCA	5928
15 Increased Starch ADPGPP <i>Oryza sativa</i> Thr96Lys ACC-AAA	CATTCCGGAGGAACCTTTCGGGATCCAAATGAGGTTGCTGCTGTTA TATTGGGTGGTGGCA <u>AA</u> GGGACTCAACTTTTTCTCTCACAAAGCA CAAGGGCCACGCCTGCTGTTCTTATTGGAGG	5929
	CCTCCAATAGGAACAGCAGGCGTGGCCCTTGTGCTTGTGAGAGG AAAAAGTTGAGTCCCTTTGCCACCACCCAATATAACAGCAGCAAC CTCATTTGGATCCGCAAGTTCTCCGGAATG	5930
	TGGTGGCA <u>AA</u> GGGACTC	5931
	GAGTCCCTTTGCCACCA	5932
20 Increased Starch ADPGPP <i>Oryza sativa</i> Pro124Leu CCC-CTC	CAAGCACAAAGGGCCACGCCTGCTGTTCTTATTGGAGGATGCTATA GGCTTATCGATATCC <u>IC</u> ATGAGCAACTGTTTCAACAGTGGCATAAA CAAGATATTCATAATGACTCAATTCAACTC	5933
	GAGTTGAATTGAGTCATTATGAATATCTTGTTTATGCCACTGTTGAA ACAGTTGCTCATG <u>AG</u> GATATCGATAAGCCTATAGCATCCTCCAATA GGAACAGCAGGCGTGGCCCTTGTGCTTG	5934
	CGATATCC <u>IC</u> ATGAGCA	5935
	TGCTCATG <u>AG</u> GATATCG	5936
25 Increased Starch ADPGPP <i>Oryza sativa</i> Gly159Asn GGA-AAT	TGACTCAATTCAACTCAGCATCTCTTAATCGTCACATTCATCGTAC GTACCTTGGTGGT <u>AAT</u> ATCAACTTTACTGATGGTTCTGTTGAGGTA TTAGCCGCTACACAAATGCCTGGGGAGGC	5937
	GCCTCCCCAGGCATTTGTGTAGCGGCTAATACCTCAACAGAACCA TCAGTAAAGTTGAT <u>ATT</u> ACCACCAAGGTACGTACGATGAATGTGAC GATTAAGAGATGCTGAGTTGAATTGAGTCA	5938

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGGTGGT <u>AAT</u> ATCAACT	5939
	AGTTGATATTACCACCA	5940
Increased Starch ADPGPP <i>Oryza sativa</i> Gly159Asn GGA-AAC	TGACTCAATTCAACTCAGCATCTCTTAATCGTCACATTCATCGTAC GTACCTTGGTGGT <u>AAC</u> ATCAACTTTACTGATGGTTCTGTTGAGGTA TTAGCCGCTACACAAATGCCTGGGGAGGC	5941
	GCCTCCCCAGGCATTTGTGTAGCGGCTAATACCTCAACAGAACCA TCAGTAAAGTTGAT <u>GTT</u> ACCACCAAGGTACGTACGATGAATGTGA CGATTAAGAGATGCTGAGTTGAATTGAGTCA	5942
	TGGTGGT <u>AAC</u> ATCAACT	5943
	AGTTGAT <u>GTT</u> ACCACCA	5944
Increased Starch ADPGPP <i>Triticum aestivum</i> Thr80Lys ACC-AAA	GTCCTTCAGGAGGATTAAGCGATCCGAACGAGGTTGCGGCCGTC ATACTCGGCGGCGGCA <u>AA</u> GGGACTCAGCTCTTCCCACTCACGAG CACAAGGGCCACACCTGCTGTTCTTATTGGAGG	5945
	CCTCCAATAGGAACAGCAGGTGTGGCCCTTGTGCTCGTGAGTGG GAAGAGCTGAGTCCCTTTGCCGCGCCGAGTATGACGGCCGCAA CCTCGTTCGGATCGCTTAATCCTCCTGAAGGAC	5946
	CGGCGGCA <u>AA</u> GGGACTC	5947
	GAGTCCCTTTGCCGCCG	5948
Increased Starch ADPGPP <i>Triticum aestivum</i> Pro108Leu CCC-CTC	CGAGCACAAGGGCCACACCTGCTGTTCTTATTGGAGGATGTTACA GGCTCATCGACATTCTCATGAGCAACTGCTTCAACAGTGGCATCA ACAAGATATTGTCATGACCCAGTTCAACTC	5949
	GAGTTGAAGTGGGTCATGACGAATATCTTGTTGATGCCACTGTTG AAGCAGTTGCTCATG <u>AGA</u> ATGTGCGATGAGCCTGTAACATCCTCCA ATAGGAACAGCAGGTGTGGCCCTTGTGCTCG	5950
	CGACATTCTCATGAGCA	5951
	TGCTCATG <u>AGA</u> ATGTGCG	5952
Increased Starch ADPGPP <i>Triticum aestivum</i> Gly143Asn GGA-AAT	TGACCCAGTTCAACTCGGCCTCCCTTAATCGTCACATTCACCGCA CCTACCTCGGCGGG <u>AAT</u> ATCAATTTCACTGATGGATCCGTTGAGG TATTGGCCGCGACGCAAATGCCCGGGGAGGC	5953
	GCCTCCCCGGGCATTTGCGTCGCGGCCAATACCTCAACGGATCC ATCAGTGAAATTGAT <u>ATT</u> CCCGCCGAGGTAGGTGCGGTGAATGTG ACGATTAAGGGAGGCCGAGTTGAAGTGGGTCA	5954
	CGGCGGG <u>AAT</u> ATCAATT	5955
	AATTGAT <u>ATT</u> CCCGCCG	5956
Increased Starch ADPGPP <i>Triticum aestivum</i> Gly143Asn GGA-AAC	TGACCCAGTTCAACTCGGCCTCCCTTAATCGTCACATTCACCGCA CCTACCTCGGCGGG <u>AAC</u> ATCAATTTCACTGATGGATCCGTTGAGG TATTGGCCGCGACGCAAATGCCCGGGGAGGC	5957

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GCCTCCCCGGGCATTTGCGTCGCGGCCAATACCTCAACGGATCC ATCAGTGAAATTGATGTTCCCGCCGAGGTAGGTGCGGTGAATGTG ACGATTAAGGGAGGCCGAGTTGAACTGGGTCA	5958
	CGGCGGGAACATCAATT	5959
	AATTGATGTTCCCGCCG	5960
Increased Starch ADPGPP <i>Oryza sativa</i> Thr95Lys ACT-AAA	CCTCCCGAAAGAATTATGCTGATGCAAGCCACGTTTCTGCTGTCA TTTTGGGTGGAGGCAAGGAGTTCAACTCTTTCCTCTGACAAGCA CAAGGGCTACCCCGCTGTTCTGTTGGAGG	5961
	CCTCCAACAGGAACAGCGGGGGTAGCCCTTGTGCTTGTGAGAGG AAAGAGTTGAACTCCTTGCCTCCACCCAAAATGACAGCAGAAAC GTGGCTTGCATCAGCATAATTCTTTCGGGAGG	5962
	TGGAGGCAAGGAGTTC	5963
	GAACTCCTTGCCTCCA	5964
Increased Starch ADPGPP <i>Oryza sativa</i> Pro123Leu CCT-CTT	CAAGCACAAAGGGCTACCCCGCTGTTCTGTTGGAGGATGTTACA GGCTTATTGACATCCTTATGAGCAATTGCTTCAATAGCGGAATAAA TAAATATTTGTGATGACTCAGTTCAATTC	5965
	GAATTGAACTGAGTCATCACAATATTTTATTATTCCGCTATTGAA GCAATTGCTCATAAGGATGTCAATAAGCCTGTAACATCCTCCAACA GGAACAGCGGGGGTAGCCCTTGTGCTTG	5966
	TGACATCCTTATGAGCA	5967
	TGCTCATAAGGATGTCA	5968
Increased Starch ADPGPP <i>Oryza sativa</i> Gly158Asn GGG-AAT	TGACTCAGTTCAATTCTGCTTCTTTAATCGCCATATCCATCATAC ATACCTTGGTGGGAATATCAACTTTACTGATGGGTCTGTGCAGGT ATTGGCTGCTACACAAATGCCTGACGAACC	5969
	GGTTCGTCAGGCATTTGTGTAGCAGCCAATACCTGCACAGACCCA TCAGTAAAGTTGATATTCCCACCAAGGTATGTATGATGGATATGGC GATTAAGAGAAGCAGAATTGAACTGAGTCA	5970
	TGGTGGGAATATCAACT	5971
	AGTTGATATTCCCACCA	5972
Increased Starch ADPGPP <i>Oryza sativa</i> Gly158Asn GGG-AAC	TGACTCAGTTCAATTCTGCTTCTTTAATCGCCATATCCATCATAC ATACCTTGGTGGGAACATCAACTTTACTGATGGGTCTGTGCAGGT ATTGGCTGCTACACAAATGCCTGACGAACC	5973
	GGTTCGTCAGGCATTTGTGTAGCAGCCAATACCTGCACAGACCCA TCAGTAAAGTTGATGTTCCCACCAAGGTATGTATGATGGATATGGC GATTAAGAGAAGCAGAATTGAACTGAGTCA	5974
	TGGTGGGAACATCAACT	5975
	AGTTGATGTTCCCACCA	5976

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Increased Starch ADPGPP <i>Triticum aestivum</i> Thr99Lys ACC-AAA	CCTTCCGCAGGAATTACGCCGATCCGAACGAGGTCGCGGCCGTC ATACTCGGCGGTGGCA <u>AA</u> GGGACTCAGCTCTTCCCTCTCACAAG CACAAGGGCCACACCTGCTGTTCTTATTGGAGG	5977
	CCTCCAATAGGAACAGCAGGTGTGGCCCTTGTGCTTGTGAGAGG GAAGAGCTGAGTCCCTTTGCCACCGCCGAGTATGACGGCCGCGA CCTCGTTCGGATCGGCGTAATTCCTGCGGAAGG	5978
	CGGTGGCA <u>AA</u> GGGACTC	5979
	GAGTCCCTTTGCCACCG	5980
10 Increased Starch ADPGPP <i>Triticum aestivum</i> Pro127Leu CCC-CTC	CAAGCACAAGGGCCACACCTGCTGTTCTTATTGGAGGATGTTACA GGCTCATCGATATTCTCATGAGCAACTGCTTCAATAGTGGCATCAA CAAGATATTCGTCATGACGCAGTTCAACTC	5981
	GAGTTGAACTGCGTCATGACGAATATCTTGTTGATGCCACTATTGA AGCAGTTGCTCATGAGAATATCGATGAGCCTGTAACATCCTCCAA TAGGAACAGCAGGTGTGGCCCTTGTGCTTG	5982
	CGATATTCTCATGAGCA	5983
	TGCTCATGAGAATATCG	5984
15 Increased Starch ADPGPP <i>Triticum aestivum</i> Gly162Asn GGA-AAT	TGACGCAGTTCAACTCGGCCTCTCTTAATCGTCACATTCACCGCA CCTACCTCGGCGGGAATATCAATTTCACTGATGGATCTGTTGAGG TATTGGCCGCGACGCAAAATGCCCGGGGAGGC	5985
	GCCTCCCCGGGCATTTGCGTCGCGGCCAATACCTCAACAGATCC ATCAGTGAAATTGATATTCCCGCCGAGGTAGGTGCGGTGAATGTG ACGATTAAGAGAGGCCGAGTTGAACTGCGTCA	5986
	CGGCGGGAATATCAATT	5987
	AATTGATATTCCCGCCG	5988
20 Increased Starch ADPGPP <i>Triticum aestivum</i> Gly162Asn GGA-AAC	TGACGCAGTTCAACTCGGCCTCTCTTAATCGTCACATTCACCGCA CCTACCTCGGCGGGAACATCAATTTCACTGATGGATCTGTTGAGG TATTGGCCGCGACGCAAAATGCCCGGGGAGGC	5989
	GCCTCCCCGGGCATTTGCGTCGCGGCCAATACCTCAACAGATCC ATCAGTGAAATTGATGTTCCCGCCGAGGTAGGTGCGGTGAATGTG ACGATTAAGAGAGGCCGAGTTGAACTGCGTCA	5990
	CGGCGGGAACATCAATT	5991
	AATTGATGTTCCCGCCG	5992
25 Increased Starch ADPGPP <i>Zea mays</i> Thr96Lys ACC-AAA	CTTTTCGGAGGAATTATGCTGATCCTAATGAAGTCGCTGCCGTCA TTTTGGGTGGTGGTA <u>AA</u> GGGACTCAGCTTTTCCCTCTCACAAGCA CAAGGGCCACCCCTGCTGTTCTTATTGGAGG	5993
	CCTCCAATAGGAACAGCAGGGGTGGCCCTTGTGCTTGTGAGAGG GAAAAGCTGAGTCCCTTTACCACCACCCAAAATGACGGCAGCGAC TTCATTAGGATCAGCATAATTCCTCCGAAAAG	5994
	TGGTGGTA <u>AA</u> GGGACTC	5995

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GAGTCCC <u>TT</u> ACCACCA	5996
Increased Starch ADPGPP <i>Zea mays</i> Pro124Leu CCC-CTC	CAAGCACAAGGGCCACCCCTGCTGTTCTATTGGAGGATGTTACA GGCTTATTGATATCCTCATGAGCAACTGTTTCAACAGTGGCATAAA CAAGATATTTGTTATGACTCAGTTCAACTC	5997
	GAGTTGAACTGAGTCATAACAAATATCTTGTTTATGCCACTGTTGA AACAGTTGCTCATGAGGATATCAATAAGCCTGTAACATCCTCCAAT AGGAACAGCAGGGGTGGCCCTTGCTGCTTG	5998
	TGATATCCTCATGAGCA	5999
	TGCTCATGAGGATATCA	6000
Increased Starch ADPGPP <i>Zea mays</i> Gly159Asn GGG-AAT	TGACTCAGTTCAACTCAGCTTCTCTTAACCGTCACATTCATCGTAC CTATCTTGGTGGGAATATCAACTTCACTGATGGATCTGTTGAGGT GCTGGCTGCAACACAAATGCCTGGGGAGGC	6001
	GCCTCCCCAGGCATTTGTGTTGCAGCCAGCACCTCAACAGATCCA TCAGTGAAGTTGATATTCCCACCAAGATAGGTACGATGAATGTGA CGGTTAAGAGAAGCTGAGTTGAACTGAGTCA	6002
	TGGTGGGAATATCAACT	6003
	AGTTGATATTCCCACCA	6004
Increased Starch ADPGPP <i>Zea mays</i> Gly159Asn GGG-AAC	TGACTCAGTTCAACTCAGCTTCTCTTAACCGTCACATTCATCGTAC CTATCTTGGTGGGAACATCAACTTCACTGATGGATCTGTTGAGGT GCTGGCTGCAACACAAATGCCTGGGGAGGC	6005
	GCCTCCCCAGGCATTTGTGTTGCAGCCAGCACCTCAACAGATCCA TCAGTGAAGTTGATGTTCCCACCAAGATAGGTACGATGAATGTGA CGGTTAAGAGAAGCTGAGTTGAACTGAGTCA	6006
	TGGTGGGAACATCAACT	6007
	AGTTGATGTTCCCACCA	6008
Increased Starch ADPGPP <i>Solanum tuberosum</i> Ala58Lys GCG-AAG	CTTGAGAGGCAAAAGAAGGGCGATGCAAGGACAGTAGTAGCAAT CATTCTAGGAGGGGGAAAGGGAACCTCGTCTTTTCCCCCTCACCAA ACGTCGTGCTAAGCCTGCCGTTCCAATGGGAG	6009
	CTCCCATTGGAACGGCAGGCTTAGCACGACGTTTGGTGAGGGGG AAAAGACGAGTTCCCTTTCCCCCTCCTAGAATGATTGCTACTACTG TCCTTGCATCGCCCTTCTTTTGCTCTCAAG	6010
	GAGGGGGAAAGGGAAC	6011
	AGTTCCC <u>TT</u> CCCCCTC	6012
Increased Starch ADPGPP <i>Solanum tuberosum</i> Pro86Leu CCA-CTA	CCAAACGTCGTGCTAAGCCTGCCGTTCCAATGGGAGGAGCATATA GGCTAATTGATGTACTAATGAGCAACTGTATTAACAGTGGCATCAA CAAAGTATACATTCTCACTCAATTCAACTC	6013
	GAGTTGAATTGAGTGAGAATGTATACTTTGTTGATGCCACTGTTAA TACAGTTGCTCATTAGTACATCAATTAGCCTATATGCTCCTCCCAT TGGAACGGCAGGCTTAGCACGACGTTTGG	6014

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGATGTACTAATGAGCA	6015
	TGCTCATTAGTACATCA	6016
Increased Starch ADPGPP <i>Solanum tuberosum</i> Gly122Asn GGG-AAT	CTCAATTCAACTCAGCCTCACTTAACAGGCATATAGCTCGTGCTTA CAACTTTGGCAATAATGTACATTCGAGAGTGGCTATGTCGAGGT CTTAGCAGCAACTCAAACACCAGGTGAATT	6017
	AATTCACCTGGTGTTTGAGTTGCTGCTAAGACCTCGACATAGCCA CTCTCGAATGTGACATTATTGCCAAAGTTGTAAGCACGAGCTATAT GCCTGTTAAGTGAGGCTGAGTTGAATTGAG	6018
	TGGCAATAATGTCACAT	6019
	ATGTGACATTATTGCCA	6020
Increased Starch ADPGPP <i>Solanum tuberosum</i> Gly122Asn GGG-AAC	CTCAATTCAACTCAGCCTCACTTAACAGGCATATAGCTCGTGCTTA CAACTTTGGCAATAACGTACATTCGAGAGTGGCTATGTCGAGGT CTTAGCAGCAACTCAAACACCAGGTGAATT	6021
	AATTCACCTGGTGTTTGAGTTGCTGCTAAGACCTCGACATAGCCA CTCTCGAATGTGACGTTATTGCCAAAGTTGTAAGCACGAGCTATAT GCCTGTTAAGTGAGGCTGAGTTGAATTGAG	6022
	TGGCAATAACGTACAT	6023
	ATGTGACGTTATTGCCA	6024
Increased Starch ADPGPP <i>Beta vulgaris</i> Ala98Lys GCT-AAA	TATTTGAATCTCCAAAAGCTGACCCAAAAAATGTGGCTGCAATTGT GCTGGGTGGTGGTAAAGGGACTCGCCTCTTTCCTCTTACTAGCA GGAGAGCTAAGCCAGCAGTGCCAATTGGAGG	6025
	CCTCCAATTGGCACTGCTGGCTTAGCTCTCCTGCTAGTAAGAGGA AAGAGGCGAGTCCCTTTACCACCACCCAGCACAAATTGCAGCCACA TTTTTTGGGTGAGCTTTTGGAGATTCAAATA	6026
	TGGTGGTAAAGGGACTC	6027
	GAGTCCCTTTACCACCA	6028
Increased Starch ADPGPP <i>Beta vulgaris</i> Ala98Lys GCT-AAC	TATTTGAATCTCCAAAAGCTGACCCAAAAAATGTGGCTGCAATTGT GCTGGGTGGTGGTAAAGGGACTCGCCTCTTTCCTCTTACTAGCA GGAGAGCTAAGCCAGCAGTGCCAATTGGAGG	6029
	CCTCCAATTGGCACTGCTGGCTTAGCTCTCCTGCTAGTAAGAGGA AAGAGGCGAGTCCCGTTACCACCACCCAGCACAAATTGCAGCCAC ATTTTTTGGGTGAGCTTTTGGAGATTCAAATA	6030
	TGGTGGTAAAGGGACTC	6031
	GAGTCCCGTTACCACCA	6032
Increased Starch ADPGPP <i>Beta vulgaris</i> Pro126Leu CCT-CTT	CTAGCAGGAGAGCTAAGCCAGCAGTGCCAATTGGAGGGTGTTAC AGGCTGATTGATGTGCTTATGAGCAACTGCATCAACAGTGGCATT AGAAAGATTTTCATTCTTACCCAGTTCAATTC	6033

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GAATTGAACTGGGTAAGAATGAAAATCTTTCTAATGCCACTGTTGA TGCAGTTGCTCATAAGCACATCAATCAGCCTGTAACACCCTCCAA TTGGCACTGCTGGCTTAGCTCTCCTGCTAG	6034
	TGATGTGCTTATGAGCA	6035
	TGCTCATAAGCACATCA	6036
Increased Starch ADPGPP <i>Beta vulgaris</i> Gly162Asn GGT-AAT	CCCAGTTCAATTCGTTTTCGCTTAATCGTCATCTTGCTCGAACCTA TAATTTTGGAGATAAATGTGAATTTGGGGATGGCTTTGTGGAGGT TTTGCTGCTACACAAACACCTGGAGAATC	6037
	GATTCTCCAGGTGTTTGTGTAGCAGCAAAAACCTCCACAAAGCCA TCCCCAAAATTCACATTATCTCCAAAATTATAGGTTGAGCAAGAT GACGATTAAGCGAAAACGAATTGAACTGGG	6038
	TGGAGATAAATGTGAATT	6039
	AATTCACATTATCTCCA	6040
	CCCAGTTCAATTCGTTTTCGCTTAATCGTCATCTTGCTCGAACCTA TAATTTTGGAGATAACGTGAATTTGGGGATGGCTTTGTGGAGGT TTTTGCTGCTACACAAACACCTGGAGAATC	6041
Increased Starch ADPGPP <i>Beta vulgaris</i> Gly162Asn GGT-AAC	GATTCTCCAGGTGTTTGTGTAGCAGCAAAAACCTCCACAAAGCCA TCCCCAAAATTCACGTTATCTCCAAAATTATAGGTTGAGCAAGAT GACGATTAAGCGAAAACGAATTGAACTGGG	6042
	TGGAGATAACGTGAATT	6043
	AATTCACGTTATCTCCA	6044

Table 21
Oligonucleotides to produce plants with waxy starch

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 10 Waxy starch GBSS <i>Arabidopsis thaliana</i> Ser12Term TCA-TGA	GAATCCAGGTAAACGGGTAGTTCATAATGGCAACTGTGACTGCTTC TTCTAACTTTGTGTGAAGAACTTCACCTTTTCAACAATCATGGTGCTT CTTCATGCTCTGATGTCGCTCAGATTAC	6045
	GTAATCTGAGCGACATCAGAGCATGAAGAAGCACCATGATTGTTGA AAAGTGAAGTTCTTCACACAAAGTTAGAAGAAGCAGTCACAGTTGC CATTATGAACTACCCGTTTACCTGGATTG	6046
	CTTTGTGTGAAGAACTT	6047
	AAGTTCTTCACACAAAG	6048
15 Waxy starch GBSS <i>Arabidopsis thaliana</i> Arg13Term AGA-TGA	ATCCAGGTAAACGGGTAGTTCATAATGGCAACTGTGACTGCTTCTT CTAACTTTGTGTCAAGAACTTCACCTTTTCAACAATCATGGTGCTTCT TCATGCTCTGATGTCGCTCAGATTACCT	6049
	AGGTAATCTGAGCGACATCAGAGCATGAAGAAGCACCATGATTGTT GAAAAGTGAAGTTCAATGACACAAAGTTAGAAGAAGCAGTCACAGTT GCCATTATGAACTACCCGTTTACCTGGAT	6050
	TTGTGTCAAGAACTTCA	6051
	TGAAGTTCAATGACACAA	6052
20 Waxy starch GBSS <i>Arabidopsis thaliana</i> Ser15Term TCA-TGA	TAAACGGGTAGTTCATAATGGCAACTGTGACTGCTTCTTCTAACTT TGTGTCAAGAACTTCACTTTTCAACAATCATGGTGCTTCTTCATGCT CTGATGTCGCTCAGATTACCTTAAAGG	6053
	CCTTTTAAGGTAATCTGAGCGACATCAGAGCATGAAGAAGCACCAT GATTGTTGAAAAGTCAAGTTCTTGACACAAAGTTAGAAGAAGCAGT CACAGTTGCCATTATGAACTACCCGTTTA	6054
	AAGAACTTGACTTTTCA	6055
	TGAAAAGTCAAGTTCTT	6056
25 Waxy starch GBSS <i>Arabidopsis thaliana</i> Ser24Term TCA-TGA	TGACTGCTTCTTCTAACTTTGTGTCAAGAACTTCACCTTTTCAACAAT CATGGTGCTTCTTGATGCTCTGATGTCGCTCAGATTACCTTAAAG GCCAATCCTTGACTCATTGTGGGTTAAG	6057
	CTTAACCCACAATGAGTCAAGGATTGGCCTTTTAAGGTAATCTGAG CGACATCAGAGCATCAAGAAGCACCATGATTGTTGAAAAGTGAAGT TCTTGACACAAAGTTAGAAGAAGCAGTCA	6058
	TGCTTCTTGATGCTCTG	6059
	CAGAGCATCAAGAAGCA	6060

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
5 Waxy starch GBSS <i>Arabidopsis thaliana</i> Cys25Term TGC-TGA	TGCTTCTTCTAACCTTTGTGTCAAGAACTTCACTTTTCAACAATCATG GTGCTTCTTCATGATCTGATGTCGCTCAGATTACCTTAAAAGGCCA ATCCTTGAATCATTGTGGGTAAAGGTCA	6061
	TGACCTTAACCCACAATGAGTCAAGGATTGGCCTTTTAAGGTAATC TGAGCGACATCAGATCATGAAGAAGCACCATTGATTGTTGAAAAGTG AAGTTCTTGACACAAAGTTAGAAGAAGCA	6062
	TCTTCATGATCTGATGT	6063
	ACATCAGATCATGAAGA	6064
10 Waxy starch GBSS <i>Antirrhinum majus</i> Lys24Term AAA-TAA	GTAACAGCTTCACAGTTGGTGTACATGTCCATGGTGGAGCAACG TCTTCACCGGATACTTAAACAACTTGGCCCAGGTTGGCCTCAGG AACCAGCAATTCACCTACAATGGGTTGAGAT	6065
	ATCTCAACCCATTGTGAGTGAATTGCTGGTTCCTGAGGCCAACCT GGGCCAAGTTTGTTTAAGTATCCGGTGAAGACGTTGCTCCACCAT GGACATGTGACACCAACTGTGAAGCTGTTAC	6066
	CGGATACTTAAACAAAC	6067
	GTTTGTTTAAGTATCCG	6068
15 Waxy starch GBSS <i>Antirrhinum majus</i> Leu27Term TTG-TAG	CACAGTTGGTGTACATGTCCATGGTGGAGCAACGTCTTCACCGG ATACTAAACAACTAGGCCAGGTTGGCCTCAGGAACCAGCAAT TCACTCACAATGGGTTGAGATCAATAAACAT	6069
	ATGTTTATTGATCTCAACCCATTGTGAGTGAATTGCTGGTTCCTGA GGCCAACCTGGGCCAGTTTGTTTAGTATCCGGTGAAGACGTTG CTCCACCATTGGACATGTGACACCAACTGTG	6070
	AACAACTAGGCCAGG	6071
	CCTGGGCCAGTTTGT	6072
20 Waxy starch GBSS <i>Antirrhinum majus</i> Gln29Term CAG-TAG	TTGGTGTACATGTCCATGGTGGAGCAACGTCTTCACCGGATACT AAAACAACTTGGCCTAGGTTGGCCTCAGGAACCAGCAATTCAT CACAATGGGTTGAGATCAATAAACATGGTTG	6073
	CAACCATGTTTATTGATCTCAACCCATTGTGAGTGAATTGCTGGTT CCTGAGGCCAACCTAGGCCAAGTTTGTTTAGTATCCGGTGAAGA CGTTGCTCCACCATTGGACATGTGACACCAA	6074
	ACTTGGCCTAGGTTGGC	6075
	GCCAACCTAGGCCAAGT	6076
25 Waxy starch GBSS <i>Antirrhinum majus</i> Gln35Term CAG-TAG	GGTGGAGCAACGTCTTCACCGGATACTAAACAACTTGGCCCAG GTTGGCCTCAGGAACAGCAATTCATCACAATGGGTTGAGATCAA TAAACATGGTTGATAAGCTTCAAATGAGGA	6077
	TCCTCATTTGAAGCTTATCAACCATGTTTATTGATCTCAACCCATTG TGAGTGAATTGCTAGTTCTGAGGCCAACCTGGGCCAAGTTTGT TTAGTATCCGGTGAAGACGTTGCTCCACC	6078

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
5	TCAGGAACTAGCAATTC	6079
	GAATTGCTAGTTCCTGA	6080
	GGAGCAACGTCTTCACCGGATACTAAAACAACTTGGCCCAGGTT GGCCTCAGGAACCAGTAATCACTCACAATGGGTTGAGATCAATAA ACATGGTTGATAAGCTTCAAATGAGGAACA	6081
	TGTTCTCATTTGAAGCTTATCAACCATGTTTATTGATCTCAACCCA TTGTGAGTGAATTACTGGTTCCTGAGGCCAACCTGGGCCAAGTTT GTTTTAGTATCCGGTGAAGACGTTGCTCC	6082
10	GGAACCAGTAATCACT	6083
	AGTGAATTACTGGTTC	6084
	GTGATGGCGACTATAACTGCCTCACACTTTGTTTCTCATGTCTGTG GGGGTGCCACTTCTTGAGAATCAAAGTGGGGTTGGGTCAATTAG CCCTGAGGAGCCAAGCTGTGACTCACAATG	6085
	CATTGTGAGTCACAGCTTGGCTCCTCAGGGCTAATTGACCCAACC CCACTTTTGATTCTCAAGAAGTGGCACCCCCACAGACATGAGAAA CAAAGTGTGAGGCAGTTATAGTCGCCATCAC	6086
15	CCACTTCTTGAGAATCA	6087
	TGATTCTCAAGAAGTGG	6088
	ATGGCGACTATAACTGCCTCACACTTTGTTTCTCATGTCTGTGGGG GTGCCACTTCTGGATAATCAAAGTGGGGTTGGGTCAATTAGCCC TGAGGAGCCAAGCTGTGACTCACAATGGGT	6089
	ACCCATTGTGAGTCACAGCTTGGCTCCTCAGGGCTAATTGACCCA ACCCCACTTTTGATTATCCAGAAGTGGCACCCCCACAGACATGAG AAACAAAGTGTGAGGCAGTTATAGTCGCCAT	6090
20	CTTCTGGATAATCAAAA	6091
	TTTTGATTATCCAGAAG	6092
	CGACTATAACTGCCTCACACTTTGTTTCTCATGTCTGTGGGGGTGC CACTTCTGGAGAATGAAAAGTGGGGTTGGGTCAATTAGCCCTGAG GAGCCAAGCTGTGACTCACAATGGGTGAG	6093
	CTCAACCCATTGTGAGTCACAGCTTGGCTCCTCAGGGCTAATTGA CCCAACCCCACTTTTCACTTCTCCAGAAGTGGCACCCCCACAGACA TGAGAAACAAAGTGTGAGGCAGTTATAGTCG	6094
	TGGAGAATGAAAAGTGG	6095
	CCACTTTTCACTTCTCCA	6096

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Waxy starch GBSS <i>Ipomoea batatas</i> Lys23Term AAA-TAA	ACTATAACTGCCTCACACTTTGTTTCTCATGTCTGTGGGGGTGCCA CTTCTGGAGAATCATAGTGGGGTTGGGTCAATTAGCCCTGAGGA GCCAAGCTGTGACTCACAATGGGTTGAGAC	6097
	GTCTCAACCCATTGTGAGTCACAGCTTGGCTCCTCAGGGCTAATT GACCCAACCCCACTTATGATTCTCCAGAAGTGGCACCCCCACAGA CATGAGAAACAAAGTGTGAGGCAGTTATAGT	6098
	GAGAATCATAGTGGGG	6099
	CCCCACTTATGATTCTC	6100
10 Waxy starch GBSS <i>Ipomoea batatas</i> Leu26Term TTG-TAG	CCTCACACTTTGTTTCTCATGTCTGTGGGGGTGCCACTTCTGGAGA ATCAAAAGTGGGGTAGGGTCAATTAGCCCTGAGGAGCCAAGCTGT GACTCACAATGGGTTGAGACCTGTGAACAA	6101
	TTGTTACAGGTCTCAACCCATTGTGAGTCACAGCTTGGCTCCTCA GGGCTAATTGACCCCTACCCCACTTTTGATTCTCCAGAAGTGGCAC CCCCACAGACATGAGAAACAAAGTGTGAGG	6102
	AGTGGGGTAGGGTCAAT	6103
	ATTGACCCCTACCCCACT	6104
15 Waxy starch GBSS <i>Astragalus membranaeus</i> Tyr8Term TAT-TAG	CATCGGCGATTGTTGCTCCTTACTGCTCTCTCACAGAATGGCAAC GGTGACGGGGTCTTAGGTGGTGTGAGAAGCGCGTGCTTCAATTC CCAGGGAAGAACAGAAGCCAAAGTGAATTCA	6105
	TGAATTCACCTTTGGCTTCTGTTCTTCCCTGGGAATTGAAGCACGCG CTTCTCGACACCACCTAAGACCCCGTCACCGTTGCCATTCTGTGA GAGAGCAGTAAGGAGCAACAATCGCCGATG	6106
	GGGTCTTAGGTGGTGTG	6107
	GACACCACCTAAGACCC	6108
20 Waxy starch GBSS <i>Astragalus membranaeus</i> Ser11Term TCG-TAG	ATTGTTGCTCCTTACTGCTCTCTCACAGAATGGCAACGGTGACGG GGTCTTATGTGGTGTAGAGAAGCGCGTGCTTCAATCCCAGGGAA GAACAGAAGCCAAAGTGAATTCACCTCAGAA	6109
	TTCTGAGGTGAATTCACCTTGGCTTCTGTTCTTCCCTGGGAATTGA AGCACGCGCTTCTCTACACCACATAAGACCCCGTCACCGTTGCCA TTCTGTGAGAGAGCAGTAAGGAGCAACAAT	6110
	TGTGGTGTAGAGAAGCG	6111
	CGCTTCTCTACACCACA	6112

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Waxy starch GBSS <i>Astragalus membranaeus</i> Arg12Term AGA-TGA	TGTTGCTCCTTACTGCTCTCTCACAGAATGGCAACGGTGACGGGG TCTTATGTGGTGTCTGGAAGCGCGTGCTTCAATTCCCAGGGAAGA ACAGAAGCCAAAGTGAATTCACCTCAGAAGA	6113
	TCTTCTGAGGTGAATTCACTTTGGCTTCTGTTCTTCCCTGGGAATT GAAGCACGCGCTTCACGACACCACATAAGACCCCGTCACCGTTGC CATTCTGTGAGAGAGCAGTAAGGAGCAACA	6114
	TGGTGTCTGGAAGCGCG	6115
	CGCGCTTCACGACACCA	6116
10 Waxy starch GBSS <i>Astragalus membranaeus</i> Cys15Term TGC-TGA	ACTGCTCTCTCACAGAATGGCAACGGTGACGGGGTCTTATGTGGT GTCGAGAAGCGCGTGATTCAATTCAGGGAAGAACAGAAGCCAA AGTGAATTCACCTCAGAAGATAAATCTCAAT	6117
	ATTGAGATTTATCTTCTGAGGTGAATTCACTTTGGCTTCTGTTCTTC CCTGGGAATTGAATCACGCGCTTCTCGACACCACATAAGACCCCG TCACCGTTGCCATTCTGTGAGAGAGCAGT	6118
	AGCGCGTGATTCAATTC	6119
	GAATTGAATCACGCGCT	6120
15 Waxy starch GBSS <i>Astragalus membranaeus</i> Gln19Term CAG-TAG	CACAGAATGGCAACGGTGACGGGGTCTTATGTGGTGTGAGAAGC GCGTGCTTCAATTCCTAGGGAAGAACAGAAGCCAAAGTGAATTCA CCTCAGAAGATAAATCTCAATAGCCAAGCAT	6121
	ATGCTTGGCTATTGAGATTTATCTTCTGAGGTGAATTCACTTTGGCT TCTGTTCTTCCCTAGGAATTGAAGCACGCGCTTCTCGACACCACAT AAGACCCCGTCACCGTTGCCATTCTGTG	6122
	TCAATTCCTAGGGAAGA	6123
	TCTTCCCTAGGAATTGA	6124
20 Waxy starch GBSS <i>Solanum tuberosum</i> Ser7Term TCA-TGA	TGTAGCTTGGTAGATTCCCCTTTTTGTAGACCACACATCACATGGC AAGCATCACAGCTTGACACCACTTTGTGTCAAGAAGCCAACTTCA CTAGACACCAAATCAACCTTGTCACAGAT	6125
	ATCTGTGACAAGGTTGATTTGGTGTCTAGTGAAGTTTGGCTTCTTG ACACAAAGTGGTGTCAAGCTGTGATGCTTGCCATGTGATGTGTGG TCTACAAAAGGGGAATCTACCAAGCTACA	6126
	CACAGCTTGACACCACT	6127
	AGTGGTGTCAAGCTGTG	6128
25 Waxy starch GBSS <i>Solanum tuberosum</i> Ser12Term TCA-TGA	TCCCCTTTTTGTAGACCACACATCACATGGCAAGCATCACAGCTTC ACACCACTTTGTGTGAAGAAGCCAACTTCACTAGACACCAAATCA ACCTTGTCACAGATAGGACTCAGGAACCA	6129
	TGGTTCCTGAGTCCTATCTGTGACAAGGTTGATTTGGTGTCTAGTG AAGTTTGGCTTCTTCACACAAAGTGGTGTGAAGCTGTGATGCTTGC CATGTGATGTGTGGTCTACAAAAGGGGA	6130

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CTTTGTGTGAAGAAGCC	6131
	GGCTTCTTCACACAAAG	6132
5 Waxy starch GBSS <i>Solanum tuberosum</i> Arg13Term AGA-TGA	CCCTTTTTGTAGACCACACATCACATGGCAAGCATCACAGCTTCAC ACCACTTTGTGTCA <u>T</u> GAAGCCAACTTCACTAGACACCAAATCAAC CTTGTCACAGATAGGACTCAGGAACCATA	6133
	TATGGTTCCTGAGTCCTATCTGTGACAAGGTTGATTTGGTGTCTAG TGAAGTTTGGCTTCATGACACAAAGTGGTGTGAAGCTGTGATGCTT GCCATGTGATGTGTGGTCTACAAAAAGGG	6134
	TTGTGTCA <u>T</u> GAAGCCAA	6135
	TTGGCTTCATGACACAA	6136
10 Waxy starch GBSS <i>Solanum tuberosum</i> Gln15Term CAA-TAA	TTGTAGACCACACATCACATGGCAAGCATCACAGCTTCACACCACT TTGTGTCAAGAAGCTAACTTCACTAGACACCAAATCAACCTTGTG ACAGATAGGACTCAGGAACCATACTCTGA	6137
	TCAGAGTATGGTTCCTGAGTCCTATCTGTGACAAGGTTGATTTGGT GTCTAGTGAAGTTTAGCTTCTTGACACAAAGTGGTGTGAAGCTGTG ATGCTTGCCATGTGATGTGTGGTCTACAA	6138
	CAAGAAGCTAACTTCA	6139
	TGAAGTTTAGCTTCTTG	6140
15 Waxy starch GBSS <i>Solanum tuberosum</i> Ser17Term TCA-TGA	CCACACATCACATGGCAAGCATCACAGCTTCACACCACTTTGTGTC AAGAAGCCAACTTGACTAGACACCAAATCAACCTTGTACAGATA GGAATCAGGAACCATACTCTGACTCACAA	6141
	TTGTGAGTCAGAGTATGGTTCCTGAGTCCTATCTGTGACAAGGTTG ATTTGGTGTCTAGTCAAGTTTGGCTTCTTGACACAAAGTGGTGTGA AGCTGTGATGCTTGCCATGTGATGTGTGG	6142
	CCAACTTGACTAGACA	6143
	TGTCTAGTCAAGTTTGG	6144
20 Waxy starch GBSS <i>Pisum sativum</i> Gly6Term GGA-TGA	GTCGATCACTCTTCTCTACCGCCGAAACAGATTTTGACACAAAAA TGGCAACAATAACGTGATCTTCAATGCCGACGAGAACCGCGTGCT TCAATTACCAAGGAAGATCAGCAGAGTCTA	6145
	TAGACTCTGCTGATCTTCCTTGGTAATTGAAGCACGCGGTTCTCGT CGGCATTGAAGATCACGTTATTGTTGCCATTTTGTGTCAAATCT GTTTCGGCGGTGAGAGAAGAGTGATCGAC	6146
	CAATAACGTGATCTTCA	6147
	TGAAGATCACGTTATTG	6148

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Waxy starch GBSS <i>Pisum sativum</i> Ser8Term TCA-TGA	ACTCTTCTCTCACCGCCGAAACAGATTTTGACACAAAAATGGCAAC AATAACGGGATCTTGAATGCCGACGAGAACC GCGTGCTTCAATTA CCAAGGAAGATCAGCAGAGTCTAAACTGAA	6149
	TTCAGTTTAGACTCTGCTGATCTTCCTTGGTAATTGAAGCACGCGG TTCTCGTCGGCATTCAAGATCCCGTTATTGTTGCCATTTTGTGTC AAAATCTGTTTCGGCGGTGAGAGAAGAGT	6150
	GGGATCTTGAATGCCGA	6151
	TCGGCATTCAAGATCCC	6152
10 Waxy starch GBSS <i>Pisum sativum</i> Arg12Term AGA-TGA	ACCGCCGAAACAGATTTTGACACAAAAATGGCAACAATAACGGGAT CTTCAATGCCGACGTGAACCGCGTGCTTCAATTACCAAGGAAGAT CAGCAGAGTCTAAACTGAATTTGCCTCAGA	6153
	TCTGAGGCAAATTCAGTTTAGACTCTGCTGATCTTCCTTGGTAATT GAAGCACGCGGTTACGTCGGCATTGAAGATCCCGTTATTGTTGC CATTTTGTGTCAAAATCTGTTTCGGCGGT	6154
	TGCCGACGTGAACCGCG	6155
	CGCGGTTACGTCGGCA	6156
15 Waxy starch GBSS <i>Pisum sativum</i> Cys15Term TGC-TGA	AGATTTTGACACAAAAATGGCAACAATAACGGGATCTTCAATGCCG ACGAGAACC GCGTGATTCAATTACCAAGGAAGATCAGCAGAGTCT AAACTGAATTTGCCTCAGATACACTTCAAT	6157
	ATTGAAGTGTATCTGAGGCAAATTCAGTTTAGACTCTGCTGATCTT CCTTGGTAATTGAATCACGCGGTTCTCGTCGGCATTGAAGATCCC GTTATTGTTGCCATTTTGTGTCAAAATCT	6158
	ACCGCGTGATTCAATTA	6159
	TAATTGAATCACGCGGT	6160
20 Waxy starch GBSS <i>Pisum sativum</i> Tyr18Term TAC-TAG	CACAAAAATGGCAACAATAACGGGATCTTCAATGCCGACGAGAAC CGCGTGCTTCAATTAGCAAGGAAGATCAGCAGAGTCTAAACTGAAT TTGCCTCAGATACACTTCAATAACAACCAA	6161
	TTGGTTGTTATTGAAGTGTATCTGAGGCAAATTCAGTTTAGACTCTG CTGATCTTCCTTGCTAATTGAAGCACGCGGTTCTCGTCGGCATTGA AGATCCCGTTATTGTTGCCATTTTGTG	6162
	TTCAATTAGCAAGGAAG	6163
	CTTCCTTGCTAATTGAA	6164
25 Waxy starch GBSS <i>Manihot esculenta</i> Ser14Term TCA-TGA	TCTACACCGGAGAGAGCACCATGGCAACTGTAATAGCTGCACATT TCGTTTCCAGGAGCTGACACTTGAGCATCCATGCATTAGAGACTAA GGCTAATAATTTGTCTCACTGGACCCTG	6165
	CAGGGTCCAGTGTGAGACAAATTATTAGCCTTAGTCTCTAATGCAT GGATGCTCAAGTGTGAGCTCCTGGAAACGAAATGTGCAGCTATTA CAGTTGCCATGGTGCTCTCTCCGGTGTAGA	6166

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CAGGAGCTGACACTTGA	6167
	TCAAGTGTGAGCTCCTG	6168
5 Waxy starch GBSS <i>Manihot esculenta</i> Leu16Term TTG-TAG	CCGGAGAGAGCACCATGGCAACTGTAATAGCTGCACATTTGTTTT CCAGGAGCTCACACTAGAGCATCCATGCATTAGAGACTAAGGCTA ATAATTTGTCTCACACTGGACCCTGGACCCA	6169
	TGGGTCCAGGGTCCAGTGTGAGACAAATTATTAGCCTTAGTCTCTA ATGCATGGATGCTCTAGTGTGAGCTCCTGGAAACGAAATGTGCAG CTATTACAGTTGCCATGGTGCTCTCTCCGG	6170
	CTCACACTAGAGCATCC	6171
	GGATGCTCTAGTGTGAG	6172
10 Waxy starch GBSS <i>Manihot esculenta</i> Leu21Term TTA-TGA	TGGCAACTGTAATAGCTGCACATTTGTTTTCCAGGAGCTCACACTT GAGCATCCATGCATGAGAGACTAAGGCTAATAATTTGTCTCACACT GGACCCTGGACCCAACTATCACTCCCAA	6173
	TTGGGAGTGATAGTTTGGGTCCAGGGTCCAGTGTGAGACAAATTA TTAGCCTTAGTCTCTCATGCATGGATGCTCAAGTGTGAGCTCCTGG AAACGAAATGTGCAGCTATTACAGTTGCCA	6174
	CCATGCATGAGAGACTA	6175
	TAGTCTCTCATGCATGG	6176
15 Waxy starch GBSS <i>Manihot esculenta</i> Glu22Term GAG-TAG	GCAACTGTAATAGCTGCACATTTGTTTTCCAGGAGCTCACACTTGA GCATCCATGCATTATAGACTAAGGCTAATAATTTGTCTCACACTGG ACCCTGGACCCAACTATCACTCCCAATG	6177
	CATTGGGAGTGATAGTTTGGGTCCAGGGTCCAGTGTGAGACAAAT TATTAGCCTTAGTCTATAATGCATGGATGCTCAAGTGTGAGCTCCT GGAAACGAAATGTGCAGCTATTACAGTTGC	6178
	ATGCATTATAGACTAAG	6179
	CTTAGTCTATAATGCAT	6180
20 Waxy starch GBSS <i>Manihot esculenta</i> Lys24Term AAG-TAG	GTAATAGCTGCACATTTGTTTTCCAGGAGCTCACACTTGAGCATCC ATGCATTAGAGACTTAGGCTAATAATTTGTCTCACACTGGACCCTG GACCCAACTATCACTCCCAATGGTTTAA	6181
	TTAAACCATTGGGAGTGATAGTTTGGGTCCAGGGTCCAGTGTGAG ACAAATTATTAGCCTAAGTCTCTAATGCATGGATGCTCAAGTGTGA GCTCCTGGAAACGAAATGTGCAGCTATTAC	6182
	TAGAGACTTAGGCTAAT	6183
	ATTAGCCTAAGTCTCTA	6184

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Waxy starch GBSS <i>Phaseolus vulgaris</i> Ser12Term TCA-TGA	ACAACTCCTCCGTCACCGGTATAAGCATGGCAACGGTATCGATGG CATCGTGCGTGGCGTGAAGAGGCGCGTGGAGTACAGAGACAAAA GTGAAATCTTCGGGTGAGATGAGCCTGAACCG	6185
	CGGTTCAAGGCTCATCTGACCCGAAGATTTCACTTTTGTCTCTGTAC TCCACGCGCCTTTTCACGCCACGCACGATGCCATCGATACCGTTG CCATGCTTATACCGGTGACGGAGGAGTTGT	6186
	CGTGGCGTGAAGAGGCG	6187
	CGCCTTTTCACGCCACG	6188
10 Waxy starch GBSS <i>Phaseolus vulgaris</i> Trp16Term TGG-TGA	CACCGGTATAAGCATGGCAACGGTATCGATGGCATCGTGCGTGGC GTCAAGAGGCGCGTGAAGTACAGAGACAAAAGTGAATCTTCGGG TCAGATGAGCCTGAACCGTCATGAATTGAAA	6189
	TTTCAATTCATGACGGTTCAGGCTCATCTGACCCGAAGATTTCACT TTTGTCTCTGTACTTCACGCGCCTTTTGACGCCACGCACGATGCC ATCGATACCGTTGCCATGCTTATACCGGTG	6190
	GGCGCGTGAAGTACAGA	6191
	TCTGTACTTCACGCGCC	6192
15 Waxy starch GBSS <i>Phaseolus vulgaris</i> Glu19Term GAG-TAG	ATAAGCATGGCAACGGTATCGATGGCATCGTGCGTGGCGTCAAAA GGCGCGTGGAGTACATAGACAAAAGTGAATCTTCGGGTGAGATG AGCCTGAACCGTCATGAATTGAAATACGATG	6193
	CATCGTATTTCAATTCATGACGGTTCAGGCTCATCTGACCCGAAGA TTTCACTTTTGTCTATGTACTCCACGCGCCTTTTGACGCCACGCAC GATGCCATCGATACCGTTGCCATGCTTAT	6194
	GGAGTACATAGACAAA	6195
	TTTTGTCTATGTACTCC	6196
20 Waxy starch GBSS <i>Phaseolus vulgaris</i> Lys21Term AAA-TAA	ATGGCAACGGTATCGATGGCATCGTGCGTGGCGTCAAGGCGC GTGGAGTACAGAGACATAAGTGAATCTTCGGGTGAGATGAGCCT GAACCGTCATGAATTGAAATACGATGGGTTGA	6197
	TCAACCCATCGTATTTCAATTCATGACGGTTCAGGCTCATCTGACC CGAAGATTTCACTTATGTCTCTGTACTCCACGCGCCTTTTGACGCC ACGCACGATGCCATCGATACCGTTGCCAT	6198
	CAGAGACATAAGTGAAA	6199
	TTTCACTTATGTCTCTG	6200
25 Waxy starch GBSS <i>Phaseolus vulgaris</i> Lys23Term AAA-TAA	ACGGTATCGATGGCATCGTGCGTGGCGTCAAGGCGCGTGGAG TACAGAGACAAAAGTGTAATCTTCGGGTGAGATGAGCCTGAACCG TCATGAATTGAAATACGATGGGTTGAGATCTC	6201
	GAGATCTCAACCCATCGTATTTCAATTCATGACGGTTCAGGCTCAT CTGACCCGAAGATTACACTTTTGTCTCTGTACTCCACGCGCCTTTT GACGCCACGCACGATGCCATCGATACCGT	6202

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CAAAAGTGT <u>A</u> TCTTCG	6203
	CGAAGATT <u>A</u> CACTTTTG	6204
Waxy starch GBSS <i>Triticum aestivum</i> Tyr7Term TAT-TAG	GCGCCTAGCTCGAAAAGGTCGTCATTGAGAGGCTGCACCAATGG GTTCCATTCCCTAATTAGTGTTCCTTATCAAACAAACAGTGTGGTTCA CTGAAACTGTGCGCTCACATCCAATTCCAG	6205
	CTGGAATTGGATGTGAGGCGACAGTTTCAGTGAACCAACACTGTTT GTTTGATAAGAACA <u>C</u> TAAATAGGAATGGAACCCATTGGTGCAGCCT CTCAATGACGACCTTTTCGAGCTAGGCGC	6206
	CCTAATTAGTGTTCCTTA	6207
	TAAGAACA <u>C</u> TAAATAGG	6208
Waxy starch GBSS <i>Triticum aestivum</i> Cys8Term TGT-TGA	CCTAGCTCGAAAAGGTCGTCATTGAGAGGCTGCACCAATGGGTTCC CATTCCCTAATTATTGATCTTATCAAACAAACAGTGTGGTTCACTGA AACTGTGCGCTCACATCCAATTCCAGCAA	6209
	TTGCTGGAATTGGATGTGAGGCGACAGTTTCAGTGAACCAACACT GTTTGTTTGATAAGATCAATAATTAGGAATGGAACCCATTGGTGCA GCCTCTCAATGACGACCTTTTCGAGCTAGG	6210
	AATTATTGATCTTATCA	6211
	TGATAAGATCAATAATT	6212
Waxy starch GBSS <i>Triticum aestivum</i> Tyr10Term TAT-TAG	TCGAAAAGGTCGTCATTGAGAGGCTGCACCAATGGGTTCCATTCC TAATTATTGTTCTTAGCAAACAAACAGTGTGGTTCACTGAAACTGT CGCCTCACATCCAATTCCAGCAATCTTGT	6213
	ACAAGATTGCTGGAATTGGATGTGAGGCGACAGTTTCAGTGAACC AACACTGTTTGTTTGCTAAGAACAATAATTAGGAATGGAACCCATT GGTGCAGCCTCTCAATGACGACCTTTTCGA	6214
	TGTTCTTAGCAAACAAA	6215
	TTTGTTTGCTAAGAACA	6216
Waxy starch GBSS <i>Triticum aestivum</i> Gln11Term CAA-TAA	CGAAAAGGTCGTCATTGAGAGGCTGCACCAATGGGTTCCATTCCCT AATTATTGTTCTTATTAACAAACAGTGTGGTTCACTGAAACTGTC GCCTCACATCCAATTCCAGCAATCTTGTA	6217
	TACAAGATTGCTGGAATTGGATGTGAGGCGACAGTTTCAGTGAAC CAACACTGTTTGTTTAATAAGAACAATAATTAGGAATGGAACCCATT GGTGCAGCCTCTCAATGACGACCTTTTCG	6218
	GTTCTTATTAAACAAAC	6219
	GTTTGTTTAATAAGAAC	6220

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Waxy starch GBSS <i>Triticum aestivum</i> Ser17Term TCA-TGA	AGGCTGCACCAATGGGTTCCATTCCCTAATTATTGTTCTTATCAAACA AACAGTGTGGTTGACTGAACTGTCGCCTCACATCCAATTCCAGC AATCTTGTAACAATGAAGTTATGTTCT	6221
	AGGAACATAACTTCATTGTTACAAGATTGCTGGAATTGGATGTGAG GCGACAGTTTCAGTCAACCAACACTGTTTGTGGATAAGAACAATA ATTAGGAATGGAACCCATTGGTGCAGCCT	6222
	TGTTGGTTGACTGAAAC	6223
	GTTTCAGTCAACCAACA	6224
10 Waxy starch GBSS <i>Triticum aestivum</i> Gln28Term CAG-TAG	CAGCTCGCCACCTCCGGCACCGTCCTCGGCATCACCGACAGGTT CCGGCGTGACAGGTTTCTAGGGCGTGAGGCCCGGAGCCCGGCG GATGCGGCTCTCGGCATGAGGACCGTCGGAGCTA	6225
	TAGCTCCGACGGTCCTCATGCCGAGAGCCGCATCCGCCGGGCTC CGGGGCCTCACGCCCTAGAAACCTGCACGCCGGAACCTGTCGGT GATGCCGAGGACGGTGCCGGAGGTGGCGAGCTG	6226
	CAGGTTTCTAGGGCGTG	6227
	CACGCCCTAGAAACCTG	6228
15 Waxy starch GBSS <i>Triticum aestivum</i> Gly46Term GGA-TGA	GGTTTCCAGGGCGTGAGGCCCGGAGCCCGGCGGATGCGGCTC TCGGCATGAGGACCGTCTGAGCTAGCGCCGCCCAACGCAAAGC CGGAAAGCGCACCGCGGGACCCGGCGGTGCCTCT	6229
	AGAGGCACCGCCGGTCCCGCGGTGCGCTTCCGGCTTTCGCTT GGGGCGGCGCTAGCTCAGACGGTCCTCATGCCGAGAGCCGCATC CGCCGGGCTCCGGGGCCTCACGCCCTGGAAACC	6230
	GGACCGTCTGAGCTAGC	6231
	GCTAGCTCAGACGGTCC	6232
20 Waxy starch GBSS <i>Triticum aestivum</i> Gln53Term CAA-TAA	CGGAGCCCGGCGGATGCGGCTCTCGGCATGAGGACCGTCGGAG CTAGCGCCGCCCAACGTAAAGCCGGAAGCGCACCGCGGGACC CGGCGGTGCCTCTCCATGGTGGTGC GCGCCACCG	6233
	CGGTGGCGCGCACCAACCATGGAGAGGCACCGCCGGGTCCCGCG GTGCGCTTCCGGCTTTACGTTGGGGCGGCGCTAGCTCCGACGG TCCTCATGCCGAGAGCCGCATCCGCCGGGCTCCG	6234
	CCCCAACGTAAAGCCGG	6235
	CCGGCTTTACGTTGGGG	6236
25 Waxy starch GBSS <i>Triticum aestivum</i> Lys56Term AAA-TAA	GCGGATGCGGCTCTCGGCATGAGGACCGTCGGAGCTAGCGCCG CCCCAACGCAAAGCCGGTAAGCGCACCGCGGGACCCGGCGGTG CCTCTCCATGGTGGTGC GCGCCACCGGCAGCGGCG	6237
	CGCCGCTGCCGGTGGCGCGCACCAACCATGGAGAGGCACCGCCG GGTCCCGCGGTGCGCTTACCGGCTTTCGCTTGGGGCGGCGCTAG CTCCGACGGTCCTCATGCCGAGAGCCGCATCCGC	6238

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	AAAGCCGGT <u>A</u> AGCGCAC	6239
	GTGCGCTT <u>A</u> CCGGCTTT	6240
5 Waxy starch GBSS <i>Triticum aestivum</i> Glu85Term GAG-TAG	CTCTCCATGGTGGTGCGCGCCACCGGCAGCGGCGGCATGAACCT CGTGTTTCGTCGGCGCCT <u>A</u> GATGGCGCCCTGGAGCAAGACCGGCG GCCTCGGCGACGTCTCTGGGGGCCTCCCCCAG	6241
	CTGGGGGGAGGCCCCGAGGACGTGCGCGAGGCCGCCGGTCTT GCTCCAGGGCGCCATCT <u>A</u> GGCGCCGACGAACACGAGGTTTCATGC CGCCGCTGCCGGTGCGCGCACCAACCATGGAGAG	6242
	TCGGCGCC <u>T</u> AGATGGCG	6243
	CGCCATCT <u>A</u> GGCGCCGA	6244
10 Waxy starch GBSS <i>Triticum aestivum</i> Gln8Term CAG-TAG	GTCGTCTCTCGCTGCAGGTAGCCACACCCTGCGCGCGCGATGGC GGCTCTGGTCACGTCTG <u>T</u> AGCTCGCCACCTCCGGCACCGTCTCG GCATCACCGACAGGTTCCGGCGTGCGAGGTTTTTC	6245
	GAAAACCTGCACGCCGGAACCTGTCGGTGATGCCGAGGACGGTG CCGGAGGTGGCGAGCT <u>A</u> CGACGTGACCAGAGCCGCCATCGCGC GCGCAGGGTGTGGCTACCTGCAGCGAGAGACGAC	6246
	TCACGTCTG <u>T</u> AGCTCGCC	6247
	GGCGAGCT <u>A</u> CGACGTGA	6248
15 Waxy starch GBSS <i>Triticum aestivum</i> Gln28Term CAG-TAG	CAGCTCGCCACCTCCGGCACCGTCTCTCGGCATCACCGACAGGTT CCGGCGTGCGAGGTTTT <u>T</u> AGGGTGTGAGGCCCGGAGCCCGGCAG ATGCGCCGCTCGGCATGAGGACTACCGGAGCGA	6249
	TCGCTCCGGTAGTCTCATGCCGAGCGGCGCATCTGCCGGGCTC CGGGGCCCTCACACCCT <u>A</u> AAAACTGCACGCCGGAACCTGTCGGT GATGCCGAGGACGGTGCCGGAGGTGGCGAGCTG	6250
	CAGGTTTT <u>T</u> AGGGTGTG	6251
	CACACCCT <u>A</u> AAAACTG	6252
20 Waxy starch GBSS <i>Triticum aestivum</i> Lys52Term AAG-TAG	CCCCGGAGCCCGGCAGATGCGCCGCTCGGCATGAGGACTACCG GAGCGAGCGCCGCCCGT <u>A</u> GCAACAAAGCCGGAAGCGCACCG CGGGACCCGGCGGTGCCTCTCCATGGTGGTGCGCG	6253
	CGCGCACCAACATGGAGAGGCACCGCCGGGTCCCGCGGTGCGC TTTCCGGCTTTGTTGCT <u>A</u> CGGGGCGGCGCTCGCTCCGGTAGTCC TCATGCCGAGCGGCGCATCTGCCGGGCTCCGGGG	6254
	CCGCCCCG <u>T</u> AGCAACAA	6255
	TTGTTGCT <u>A</u> CGGGGCGG	6256

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
5 Waxy starch GBSS <i>Triticum aestivum</i> Gln53Term CAA-TAA	CGGAGCCCGGCAGATGCGCCGCTCGGCATGAGGACTACCGGAG CGAGCGCCGCCCGGAAGTAACAAAGCCGAAAGCGCACCGCGG GACCCGGCGGTGCCTCTCCATGGTGGTGCGCGCCA	6257
	TGGCGCGCACCAACCATGGAGAGGCACCGCCGGGTCCCGCGGTG CGCTTTCCGGCTTTGTTACTTCGGGGCGGCGCTCGCTCCGGTAG TCCTCATGCCGAGCGGCGCATCTGCCGGGCTCCG	6258
	CCCCGAAGTAACAAAGC	6259
	GCTTTGTTACTTCGGGG	6260
10 Waxy starch GBSS <i>Triticum aestivum</i> Gln54Term CAA-TAA	AGCCCGGCAGATGCGCCGCTCGGCATGAGGACTACCGGAGCGA GCGCCGCCCGGAAGCAATAAAGCCGAAAGCGCACCGCGGGAC CCGGCGGTGCCTCTCCATGGTGGTGCGCGCCACGG	6261
	CCGTGGCGCGCACCAACCATGGAGAGGCACCGCCGGGTCCCGCG GTGCGCTTTCCGGCTTTATTGCTTCGGGGCGGCGCTCGCTCCGG TAGTCCTCATGCCGAGCGGCGCATCTGCCGGGCT	6262
	CGAAGCAATAAAGCCGG	6263
	CCGGCTTTATTGCTTCG	6264
15 Waxy starch GBSS <i>Triticum durum</i> Gln28Term CAG-TAG	CAGCTCGCCACCTCCGGCACCGTCCTCGGCATCACCGACAGGTT CCGGCGTGAGGTTTCTAGGGCGTGAGGCCCGGAACCCGGCG GATGCGGCCCTCGTCATGAGGACTATCGGAGCGA	6265
	TCGCTCCGATAGTCCTCATGACGAGGGCCGCATCCGCCGGGTTC CGGGGCCCTACGCCCTAGAAACCTGCACGCCGGAACCTGTCGGT GATGCCGAGGACGGTGCCGGAGGTGGCGAGCTG	6266
	CAGGTTTCAGGGCGTG	6267
	CACGCCCTAGAAACCTG	6268
20 Waxy starch GBSS <i>Triticum durum</i> Lys52Term AAG-TAG	CCCCGGAACCCGGCGGATGCGGCCCTCGTCATGAGGACTATCGG AGCGAGCGCCGCCCGTAGCAAAGCCGAAAGCGCACCGCGGG AGCCGGCGGTGCCTCTCCATGGTGGTGCGCGCCA	6269
	TGGCGCGCACCAACCATGGAGAGGCACCGCCGGTCCCGCGGTG CGCTTTCCGGCTTTGCTACGGGGCGGCGCTCGCTCCGATAGTCC TCATGACGAGGGCCGCATCCGCCGGGTCCGGGG	6270
	CCGCCCGTAGCAAAGC	6271
	GCTTTGCTACGGGGCGG	6272
25 Waxy starch GBSS <i>Triticum durum</i> Gln53Term CAA-TAA	CGGAACCCGGCGGATGCGGCCCTCGTCATGAGGACTATCGGAGC GAGCGCCGCCCGGAAGTAAAGCCGAAAGCGCACCGCGGGAGC CGGCGGTGCCTCTCCATGGTGGTGCGCGCCACGG	6273
	CCGTGGCGCGCACCAACCATGGAGAGGCACCGCCGGTCCCGCG GTGCGCTTTCCGGCTTTACTTCGGGGCGGCGCTCGCTCCGATAG TCCTCATGACGAGGGCCGCATCCGCCGGGTCCG	6274

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
	CCCCGAAGTAAAGCCGG	6275
	CCGGCTTTACTTCGGGG	6276
Waxy starch GBSS <i>Triticum durum</i> Lys56Term AAA-TAA	GCGGATGCGGCCCTCGTCATGAGGACTATCGGAGCGAGCGCCGC CCCGAAGCAAAGCCGGTAAGCGCACCCGCGGGAGCCGGCGGTGC CTCTCCATGGTGGTGCGCGCCACGGGCAGCGGCG	6277
	CGCCGCTGCCCCGTGGCGCGCACCCACCATGGAGAGGCACCGCCG GCTCCCGCGGTGCGCTTACCGGCTTTGCTTCGGGGCGGCGCTCG CTCCGATAGTCCTCATGACGAGGGCCGCATCCGC	6278
	AAAGCCGGTAAGCGCAC	6279
	GTGCGCTTACCGGCTTT	6280
Waxy starch GBSS <i>Triticum durum</i> Cys64Term TGC-TGA	TATCGGAGCGAGCGCCGCCCGAAGCAAAGCCGGAAAGCGCACCC GCGGGAGCCGGCGGTGACTCTCCATGGTGGTGCGCGCCACGGG CAGCGCGGCATGAACCTCGTGTTCTGTCGGCGCC	6281
	GGCGCCGACGAACACGAGGTTGATGCCGCCGCTGCCCGTGGCG CGCACCACCATGGAGAGTACCGCCGGCTCCCGCGGTGCGCTTT CCGGCTTTGCTTCGGGGCGGCGCTCGCTCCGATA	6282
	CGGCGGTGACTCTCCAT	6283
	ATGGAGAGTACCGCCG	6284
Waxy starch GBSS <i>Triticum turgidum</i> Gln28Term CAG-TAG	CAGCTCGCCACCTCCGGCACCGTCCTCGGCATCACCGACAGGTT CCGGCGTGAGGTTTTAGGGTGTGAGGCCCGGAGCCCGGCAG ATGCGCCGCTCGGCATGAGGACTACCGGAGCGA	6285
	TCGCTCCGGTAGTCCTCATGCCGAGCGGCGCATCTGCCGGGCTC CGGGGCCCTCACACCCTAAAAACCTGCACGCCGGAACCTGTCGGT GATGCCGAGGACGGTGCCGGAGGTGGCGAGCTG	6286
	CAGGTTTTIAGGGTGTG	6287
	CACACCCTAAAAACCTG	6288
Waxy starch GBSS <i>Triticum turgidum</i> Lys52Term AAG-TAG	CCCCGGAGCCCGGCAGATGCGCCGCTCGGCATGAGGACTACCG GAGCGAGCGCCGCCCGTAGCAACAAAGCCGGAAAGCGCACCG CGGGACCCGGCGGTGCCTCTCCATGGTGGTGCGCG	6289
	CGCGCACCAACCATGGAGAGGCACCGCCGGGTCCCGCGGTGCGC TTTCCGGCTTTGTTGCTACGGGGCGGCGCTCGCTCCGGTAGTCC TCATGCCGAGCGGCGCATCTGCCGGGCTCCGGGG	6290
	CCGCCCCGTAGCAACAA	6291
	TTGTTGCTACGGGGCGG	6292

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO
5 Waxy starch GBSS <i>Triticum turgidum</i> Gln53Term CAA-TAA	CGGAGCCCGGCAGATGCGCCGCTCGGCATGAGGACTACCGGAG CGAGCGCCGCCCGCAAGTAACAAAGCCGAAAGCGCACCGCGG GACCCGGCGGTGCCTCTCCATGGTGGTGCGCGCCA	6293
	TGGCGCGCACCACCATGGAGAGGCACCGCCGGGTCCCGCGGTG CGCTTTCCGGCTTTGTTACTTCGGGGCGGCGCTCGCTCCGGTAG TCCTCATGCCGAGCGGCGCATCTGCCGGGCTCCG	6294
	CCCCGAAGTAACAAAGC	6295
	GCTTTGTTACTTCGGGG	6296
10 Waxy starch GBSS <i>Triticum turgidum</i> Gln54Term CAA-TAA	AGCCCGGCAGATGCGCCGCTCGGCATGAGGACTACCGGAGCGA GCGCCGCCCGCAAGCAATAAAGCCGGAAGCGCACCGCGGGAC CCGGCGGTGCCTCTCCATGGTGGTGCGCGCCACGG	6297
	CCGTGGCGCGCACCACCATGGAGAGGCACCGCCGGGTCCCGCG GTGCGCTTTCCGGCTTTATTGCTTCGGGGCGGCGCTCGCTCCGG TAGTCCTCATGCCGAGCGGCGCATCTGCCGGGCT	6298
	CGAAGCAATAAAGCCGG	6299
	CCGGCTTTATTGCTTCG	6300
15 Waxy starch GBSS <i>Triticum turgidum</i> Lys57Term AAA-TAA	GATGCGCCGCTCGGCATGAGGACTACCGGAGCGAGCGCCGCC CGAAGCAACAAAGCCGGTAAGCGCACCGCGGGACCCGGCGGTG CCTCTCCATGGTGGTGCGCGCCACGGGCAGCGCCG	6301
	CGGCGCTGCCCGTGCGCGCACCACCATGGAGAGGCACCGCCG GGTCCCGCGGTGCGCTTACCGGCTTTGTTGCTTCGGGGCGGCGC TCGCTCCGGTAGTCCTCATGCCGAGCGGCGCATC	6302
	AAAGCCGGTAAGCGCAC	6303
	GTGCGCTTACCGGCTTT	6304
20 Waxy starch GBSS <i>Aegilops speltoides</i> Gln28Term CAG-TAG	CAGCTCGCCACCTCCGCCACCGTCCTCGGCATCACCGACAGGTT CCGCCATGCAGGTTTCTAGGGCGTGAGGCCCGGAGCCCGGCAG ATGCGCCGCTCGGCATGAGGACTGTCGGAGCGA	6305
	TCGCTCCGACAGTCCTCATGCCGAGCGGCGCATCTGCCGGGCTC CGGGGCCCTACGCCCTAGAAACCTGCATGGCGGAACCTGTCGGT GATGCCGAGGACGGTGCGGAGGTGGCGAGCTG	6306
	CAGGTTTCTAGGGCGTG	6307
	CACGCCCTAGAAACCTG	6308
25 Waxy starch GBSS <i>Aegilops speltoides</i> Gly46Term GGA-TGA	GGTTTCCAGGGCGTGAGGCCCGGAGCCCGGCAGATGCGCCGC TCGGCATGAGGACTGCTGAGCGAGCGCCGCCCGCAAGCAACAA AGCCGGAAGCGCACCGCGGGACCCGGCGGTGCC	6309
	GGCACCGCCGGGTCCCGCGGTGCGCTTTCCGGCTTTGTTGCTTC GGGGCGGCGCTCGCTCAGACAGTCCTCATGCCGAGCGGCGCAT CTGCCGGGCTCCGGGGCCTCACGCCCTGGAAACC	6310

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GGA <u>CTGTCT</u> GAGCGAGC	6311
	GCTCGCTCAGACAGTCC	6312
Waxy starch GBSS <i>Aegilops speltoides</i> Lys52Term AAG-TAG	CCCCGGAGCCCGGCAGATGCGCCGCTCGGCATGAGGACTGTCTG GAGCGAGCGCCGCCCGCTAGCAACAAAGCCGAAAGCGCACCG CGGGACCCGGCGGTGCCTCTCGATGGTGGTGC	6313
	CGCGCACCACCATCGAGAGGCACCGCCGGTCCCGCGGTGCGC TTTCCGGCTTTGTTGCTACGGGGCGGCGCTCGCTCCGACAGTCC TCATGCCGAGCGGCGCATCTGCCGGGCTCCGGGG	6314
	CCGCCCGCTAGCAACAA	6315
	TTGTTGCTACGGGGCGG	6316
Waxy starch GBSS <i>Aegilops speltoides</i> Gln53Term CAA-TAA	CGGAGCCCGGCAGATGCGCCGCTCGGCATGAGGACTGTCGGAG CGAGCGCCGCCCGAAGTAACAAAGCCGAAAGCGCACCGCGG GACCCGGCGGTGCCTCTCGATGGTGGTGC	6317
	TGGCGCGCACCACCATCGAGAGGCACCGCCGGTCCCGCGGTG CGCTTTCCGGCTTTGTTACTTCGGGGCGGCGCTCGCTCCGACAG TCCTCATGCCGAGCGGCGCATCTGCCGGGCTCCG	6318
	CCCCGAAGTAACAAAGC	6319
	GCTTTGTTACTTCGGGG	6320
Waxy starch GBSS <i>Aegilops speltoides</i> Gln54Term CAA-TAA	AGCCCGGCAGATGCGCCGCTCGGCATGAGGACTGTCGGAGCGA GCGCCGCCCGAAGCAATAAAGCCGAAAGCGCACCGCGGGAC CCGGCGGTGCCTCTCGATGGTGGTGC	6321
	CGGTGGCGCGCACCACCATCGAGAGGCACCGCCGGTCCCGCG GTGCGCTTTCCGGCTTTATTGCTTCGGGGCGGCGCTCGCTCCGA CAGTCCTCATGCCGAGCGGCGCATCTGCCGGGCT	6322
	CGAAGCAATAAAGCCGG	6323
	CCGGCTTTATTGCTTCG	6324
Waxy starch GBSS <i>Oryza glaberrima</i> Gln8Term CAG-TAG	AGTGCAGAGATCTTCCACAGCAACAGCTAGACAACCACCATGTCTG GCTCTCACCACGTCTAGCTCGCCACCTCGCCACCGGCTTCGG CATCGCTGACAGGTCGGCGCCGTCTGCTGCTGC	6325
	GCAGCGACGACGGCGCCGACCTGTCAGCGATGCCGAAGCCGGT GGCCGAGGTGGCGAGCTAGGACGTGGTGAGAGCCGACATGGTG GTTGTCTAGCTGTTGCTGTGGAAGATCTCTGCACT	6326
	CCACGTCTAGCTCGCC	6327
	GGCGAGCTAGGACGTGG	6328

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Waxy starch GBSS <i>Oryza glaberrima</i> Ser12Term TCG-TAG	TCCACAGCAACAGCTAGACAACCACCATGTGGCTCTCACCACGT CCCAGCTCGCCACCTAGGCCACCGGCTTCGGCATCGCTGACAGG TCGGCGCCGTCGTGCTGCTCCGCCACGGGT	6329
	AACCCGTGGCGGAGCAGCAGCAGCGGCCGACCTGTCAGCGAT GCCGAAGCCGGTGGCCTAGGTGGCAGCTGGGACGTGGTGAGA GCCGACATGGTGGTTGTCTAGCTGTTGCTGTGGA	6330
	CGCCACCTAGGCCACCG	6331
	CGGTGGCCTAGGTGGCG	6332
10 Waxy starch GBSS <i>Oryza glaberrima</i> Ser22Term TCG-TAG	CGGCTCTCACCACGTCCCAGCTCGCCACCTCGGCCACCGGCTTC GGCATCGCTGACAGGTAGGCGCCGTGCTGCTGCTCCGCCACGG GTTCCAGGGCCTCAAGCCCCGAGCCCCGCGCGG	6333
	CCGGCGGGGCTGCGGGGCTTGAGGCCCTGGAACCCGTGGCGGA GCAGCGACGACGGCGCCTACCTGTCAGCGATGCCGAAGCCGGTG GCCGAGGTGGCGAGCTGGGACGTGGTGAGAGCCG	6334
	TGACAGGTAGGCGCCGT	6335
	ACGGCGCCTACCTGTCA	6336
15 Waxy starch GBSS <i>Oryza glaberrima</i> Ser25Term TCG-TAG	CCACGTCCCAGCTCGCCACCTCGGCCACCGGCTTCGGCATCGCT GACAGGTGGCGCCGTAGTCGCTGCTCCGCCACGGGTTCCAGG GCCTCAAGCCCCGAGCCCCGCGGGCGGCGACGC	6337
	GCGTCGCGCGCCGGCGGGGCTGCGGGGCTTGAGGCCCTGGAACC CGTGCGGAGCAGCGACTACGGCGCCGACCTGTCAGCGATGCC GAAGCCGGTGGCCGAGGTGGCGAGCTGGGACGTGG	6338
	GGCGCCGTAGTCGCTGC	6339
	GCAGCGACTACGGCGCC	6340
20 Waxy starch GBSS <i>Oryza glaberrima</i> Ser26Term TCG-TAG	CGTCCCAGCTCGCCACCTCGGCCACCGGCTTCGGCATCGCTGAC AGGTGGCGCCGTGCTAGCTGCTCCGCCACGGGTTCCAGGGCCT CAAGCCCCGAGCCCCGCGGGCGGCGACGCGAC	6341
	GTCGCGTCGCCGCCGGCGGGGCTGCGGGGCTTGAGGCCCTGGA ACCCGTGGCGGAGCAGCTACGACGGCGCCGACCTGTCAGCGATG CCGAAGCCGGTGGCCGAGGTGGCGAGCTGGGACG	6342
	GCCGTCGTAGCTGCTCC	6343
	GGAGCAGCTACGACGGC	6344
25 Waxy starch GBSS <i>Oryza sativa</i> Gln8Term CAG-TAG	TCCACAGCAAGAGCTAAACAGCCGACCGTGTGCACCACCATGTG GCTCTCACCACGTCTAGCTCGCCACCTCGGCCACCGGCTTCGG CATCGCCGACAGGTGGCGCCGTCGTGCTGCTGC	6345
	GCAGCGACGACGGCGCCGACCTGTCGGCGATGCCGAAGCCGGT GGCCGAGGTGGCGAGCTAGGACGTGGTGAGAGCCGACATGGTG GTGCACACGGTCGGCTGTTAGCTCTTGCTGTGGA	6346

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
	CCACGTCCTAGCTCGCC	6347
	GGCGAGCTAGGACGTGG	6348
5 Waxy starch GBSS <i>Oryza sativa</i> Ser12Term TCG-TAG	CTAAACAGCCGACCGTGTGCACCACCATGTCGGCTCTCACCACGT CCCAGCTCGCCACCTAGGCCACCGGCTTCGGCATCGCCGACAGG TCGGCGCCGTCGTCGCTGCTTCGCCACGGGT	6349
	AACCCGTGGCGAAGCAGCAGCAGCGGCCGACCTGTCGGCGAT GCCGAAGCCGGTGGCCTAGGTGGCGAGCTGGGACGTGGTGAGA GCCGACATGGTGGTGCACACGGTCGGCTGTTTAG	6350
	CGCCACCTAGGCCACCG	6351
	CGGTGGCCTAGGTGGCG	6352
10 Waxy starch GBSS <i>Oryza sativa</i> Ser22Term TCG-TAG	CGGCTCTCACCACGTCCCAGCTCGCCACCTCGGCCACCGGCTTC GGCATCGCCGACAGGTAGGCGCCGTCGTCGCTGCTTCGCCACGG GTTCCAGGGCCTCAAGCCCCGTAGCCCAGCCGG	6353
	CCGGCTGGGCTACGGGGCTTGAGGCCCTGGAACCCGTGGCGAA GCAGCGACGACGGCGCCTACCTGTCGGCGATGCCGAAGCCGGT GGCCGAGGTGGCGAGCTGGGACGTGGTGAGAGCCG	6354
	CGACAGGTAGGCGCCGT	6355
	ACGGCGCCTACCTGTCG	6356
15 Waxy starch GBSS <i>Oryza sativa</i> Ser25Term TCG-TAG	CCACGTCCCAGCTCGCCACCTCGGCCACCGGCTTCGGCATCGCC GACAGGTCGGCGCCGTAGTCGCTGCTTCGCCACGGGTTCCAGGG CCTCAAGCCCCGTAGCCCAGCCGGCGGGGACGC	6357
	GCGTCCCCGCCGGCTGGGCTACGGGGCTTGAGGCCCTGGAACC CGTGGCGAAGCAGCGACTACGGCGCCGACCTGTCGGCGATGCC GAAGCCGGTGGCCGAGGTGGCGAGCTGGGACGTGG	6358
	GGCGCCGTAGTCGCTGC	6359
	GCAGCGACTACGGCGCC	6360
20 Waxy starch GBSS <i>Oryza sativa</i> Ser26Term TCG-TAG	CGTCCCAGCTCGCCACCTCGGCCACCGGCTTCGGCATCGCCGAC AGGTGGCGCCGTCGTAGCTGCTTCGCCACGGGTTCCAGGGCCT CAAGCCCCGTAGCCCAGCCGGCGGGGACGCATC	6361
	GATGCGTCCCCGCCGGCTGGGCTACGGGGCTTGAGGCCCTGGA CCCGTGGCGAAGCAGCTACGACGGCGCCGACCTGTCGGCGATGC CGAAGCCGGTGGCCGAGGTGGCGAGCTGGGACG	6362
	GCCGTCGTAGCTGCTTC	6363
	GAAGCAGCTACGACGGC	6364

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Waxy starch GBSS <i>Hordeum vulgare</i> Gln8Term CAG-TAG	GTCTCTCACTGCAGGTAGCCACACCCTGTGCGCGGCCGCGCATGGC GGCTCTGGCCACGTCTAGCTCGCCACCTCCGGCACCGTCCTCG GCGTCACCGACAGATTCCGGCGTCCAGGTTTTTC	6365
	GAAAACCTGGACGCCGGAATCTGTCCGGTGACGCCGAGGACGGTG CCGGAGGTGGCGAGCTAGGACGTGGCCAGAGCCGCCATGGCGC CGCGCACAGGGTGTGGCTACCTGCAGTGAGAGAC	6366
	CCACGTCTAGCTCGCC	6367
	GGCGAGCTAGGACGTGG	6368
10 Waxy starch GBSS <i>Hordeum vulgare</i> Arg21Term AGA-TGA	ATGGCGGCTCTGGCCACGTCCCAGCTCGCCACCTCCGGCACCGT CCTCGGCGTCACCGACTGATTCCGGCGTCCAGGTTTTTCAGGGCCT CAGGCCCCGGAACCCGGCGGATGCGGCGCTTG	6369
	CAAGCGCCGCATCCGCCGGGTTCCGGGGCCTGAGGCCCTGAAAA CCTGGACGCCGGAATCAGTCGGTGACGCCGAGGACGGTGCCGG AGGTGGCGAGCTGGGACGTGGCCAGAGCCGCCAT	6370
	TCACCGACTGATTCCGG	6371
	CCGGAATCAGTCGGTGA	6372
15 Waxy starch GBSS <i>Hordeum vulgare</i> Gln28Term CAG-TAG	CAGCTCGCCACCTCCGGCACCGTCCTCGGCGTCACCGACAGATT CCGGCGTCCAGGTTTTTAGGGCCTCAGGCCCCGGAACCCGGCGG ATGCGGCGCTTGGTATGAGGACTATCGGAGCAA	6373
	TTGCTCCGATAGTCCTCATACCAAGCGCCGCATCCGCCGGGTTCC GGGGCCTGAGGCCCTAAAAACCTGGACGCCGGAATCTGTCCGTG ACGCCGAGGACGGTGCCGGAGGTGGCGAGCTG	6374
	CAGGTTTTTAGGGCCTC	6375
	GAGGCCCTAAAAACCTG	6376
20 Waxy starch GBSS <i>Hordeum vulgare</i> Gly46Term GGA-TGA	GGTTTTCAGGGCCTCAGGCCCCGGAACCCGGCGGATGCGGCGCT TGGTATGAGGACTATCTGAGCAAGCGCCGCCCGAAGCAAAGCC GGAAAGCGCACCGCGGGAGCCGGCGGTGCCTCT	6377
	AGAGGCACCGCCGGCTCCCGCGGTGCGCTTCCGGCTTTGCTTC GGGGCGGCGCTTGCTCAGATAGTCCTCATACCAAGCGCCGCATC CGCCGGGTTCCGGGGCCTGAGGCCCTGAAAACC	6378
	GGAATATCTGAGCAAGC	6379
	GCTTGCTCAGATAGTCC	6380
25 Waxy starch GBSS <i>Hordeum vulgare</i> Lys52Term AAG-TAG	CCCCGGAACCCGGCGGATGCGGCGCTTGGTATGAGGACTATCGG AGCAAGCGCCGCCCGTAGCAAAGCCGAAAGCGCACCGCGGG AGCCGGCGGTGCCTCTCCGTGGTGGTGAGCGCCA	6381
	TGGCGCTCACCACCACGAGAGGCACCGCCGGCTCCCGCGGTG CGCTTCCGGCTTTGCTACGGGGCGGCGCTTGCTCCGATAGTCC TCATACCAAGCGCCGCATCCGCCGGGTTCCGGGG	6382

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CCGCCCCG <u>T</u> AGCAAAGC	6383
	GCTTTGCT <u>A</u> CGGGGCGG	6384
Waxy starch GBSS <i>Zea mays</i> Gln8Term CAG-TAG	ACGTCTTTTCTCTCTCTCTACGCAGTGGATTAATCGGCATGGCGG CTCTGGCCACGT <u>C</u> TAGCTCGTCGCAACGCGCGCCGGCCTGGGC GTCCCGGACGCGTCCACGTTCCGCCGCGCGC	6385
	CGCCGCGGCGGAACGTGGACGCGTCCGGGACGCCAGGCCGGC GCGCGTTGCGACGAGCT <u>A</u> CGACGTGGCCAGAGCCGCCATGCCGA TTAATCCACTGCGTAGGAGAGAGAGAAAAGACGT	6386
	CCACGT <u>C</u> TAGCTCGTC	6387
	GACGAGCT <u>A</u> CGACGTGG	6388
Waxy starch GBSS <i>Zea mays</i> Gln30Term CAG-TAG	GTCGCAACGCGCGCCGGCCTGGGCGTCCCGGACGCGTCCACGT TCCGCCGCGGCGCCGCGT <u>A</u> GGGCCTGAGGGGGGCCCGGGCGTC GGCGGCGGCGGACACGCTCAGCATGCGGACCAGCG	6389
	CGCTGGTCCGCATGCTGAGCGTGTCCGCCGCGCGGACGCCCG GGCCCCCCTCAGGCCCT <u>A</u> CGCGGCGCCGCGGCGGAACGTGGAC GCGTCCGGGACGCCAGGCCGCGCGCGTTGCGAC	6390
	GCGCCGCGT <u>A</u> GGGCCTG	6391
	CAGGCCCT <u>A</u> CGCGGCGC	6392
Waxy starch GBSS <i>Zea mays</i> Ser38Term TCG-TAG	TCCCGGACGCGTCCACGTTCCGCCGCGGCGCCGCGCAGGGCCT GAGGGGGGCCCGGGCGT <u>A</u> GGCGGCGGCGGACACGCTCAGCATG CGGACCAGCGCGCGCGCGGCCAGGCACCAGCA	6393
	TGCTGGTGCCTGGGCGCCGCGCGCGCTGGTCCGCATGCTGA GCGTGTCCGCCCGCCGCT <u>A</u> CGCCCGGGCCCCCCTCAGGCCCTG CGCGGCGCCGCGGCGGAACGTGGACGCGTCCGGGA	6394
	CCGGGCGT <u>A</u> GGCGGCGG	6395
	CCGCCGCC <u>T</u> ACGCCCGG	6396
Waxy starch GBSS <i>Zea mays</i> Ser57Term CAG-TAG	GCGTCGGCGGCGGCGGACACGCTCAGCATGCGGACCAGCGCGC GCGCGGCGCCAGGCACT <u>A</u> GCAGCAGGCGCGCCGCGGGGGCA GGTCCCGTCGCTCGTCGTGTGCCACGCGCCGGCA	6397
	TGCCGGCGCTGGCGCACACGACGAGCGACGGGAACCTGCCCC GCGGCGCGCCTGCTGCT <u>A</u> GTGCCTGGGCGCCGCGCGCGCTG GTCCGCATGCTGAGCGTGTCCGCCGCGCCGACGC	6398
	CCAGGCACT <u>A</u> GCAGCAG	6399
	CTGCTGCT <u>A</u> GTGCCTGG	6400

5

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
Waxy starch GBSS <i>Zea mays</i> Gln58Term CAG-TAG	TCGGCGGCGGGCGGACACGCTCAGCATGCGGACCAGCGCGCGCG CGGCGCCAGGCACCACTAGCAGGCGCGCCGCGGGGGCAGGTT CCCGTCGCTCGTCGTGTGCGCCAGCGCCGGCATGA	6401
	TCATGCCGGCGCTGGCGCACACGACGAGCGACGGGAACCTGCCC CCGCGGCGCGCCTGCTACTGGTGCCTGGGCGCCGCGCGCGCGC TGGTCCGCATGCTGAGCGTGTCCGCCGCCGCCGA	6402
	GGCACCAGTAGCAGGCG	6403
	CGCCTGCTACTGGTGCC	6404

Example 11**Altering fatty acid content of plants**

Improved means to manipulate fatty acid compositions, from biosynthetic or natural plant sources, are needed. For example, oils containing reduced saturated fatty acids are desired for dietary reasons and oils containing increased saturated fatty acids are also needed as alternatives to current sources of highly saturated oil products, such as tropical oils or chemically hydrogenated oils. It would therefore be advantageous to influence directly the production and composition of fatty acids in crop plants.

Higher plants synthesize fatty acids, primarily palmitic, stearic and oleic acids, in the plastids (i.e., chloroplasts, proplastids, or other related organelles) as part of the Fatty Acid Synthase (FAS) complex. Fatty acid synthesis is the result of the three enzymatic activities: acyl-ACP elongase, acyl-ACP desaturase and acyl-ACP thioesterases specific for each of palmitoyl-, stearyl- and oleoyl-ACP.

A variety of enzymes have been identified that influence the relative levels of saturated vs. unsaturated fatty acids in plants. For example, the enzymes stearyl-acyl carrier protein (stearyl-ACP) desaturase, oleoyl desaturase and linoleate desaturase produce unsaturated fatty acids from saturated precursors. Similarly, relative enzymatic activities of the various acyl-ACP thioesterases influences the relative acyl-chain composition of the resultant fatty acids. Consequently a reduction or an increase of the activity of these enzymes can alter the properties of oils produced in a plant. In fact, specific targeting of particular enzymatic activities can results in altered levels of particular fatty acids.

The attached tables disclose exemplary oligonucleotides base sequences which can be used to generate site-specific mutations in plant genes encoding proteins involved in fatty acid biosynthesis.

Table 22
Oligonucleotides to produce plants with reduced palmitate

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Reduced palmitate Acyl-ACP-thioesterase <i>Arabidopsis thaliana</i> Ser8Term TCG-TAG	TTTGGTGGCAGTGTCTTTGAACGCTTCATCTCCTCGTCATGGTGCC CACCTCTGCTACGTAGTCATTCTTTCCTGTACCATCTTCTTCACTT GATCCTAATGGAAAAGGCAATAAGATTGG	6405
	CCAATCTTATTGCCTTTTCCATTAGGATCAAGTGAAGAAGATGGTA CAGGAAAGAATGACTACGTAGCAGAGGTGGCCACCATGACGAGG AGATGAAGCGTTCAAAGACACTGCCACCAA	6406

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TGCTACGTAGTCATTCT	6407
	AGAATGACTACGTAGCA	6408
5 Reduced palmitate Acyl-ACP-thioesterase <i>Arabidopsis thaliana</i> Ser9Term TCA-TGA	GGTGGCAGTGTCTTTGAACGCTTCATCTCCTCGTCATGGTGGCCA CCTCTGCTACGTCGTGATTCTTTCTGTACCATCTTCTTCACTTGAT CCTAATGGAAAAGGCAATAAGATTGGGTC	6409
	GACCCAATCTTATTGCCTTTTCCATTAGGATCAAGTGAAGAAGATG GTACAGGAAAGAATCACGACGTAGCAGAGGTGGCCACCATGACGA GGAGATGAAGCGTTCAAAGACACTGCCACC	6410
	TACGTCGTGATTCTTTC	6411
	GAAAGAATCACGACGTA	6412
10 Reduced palmitate Acyl-ACP-thioesterase <i>Arabidopsis thaliana</i> Ser17Term TCA-TGA	ATCTCCTCGTCATGGTGGCCACCTCTGCTACGTCGTCATTCTTTCC TGTACCATCTTCTTGACTTGATCCTAATGGAAAAGGCAATAAGATT GGGTCTACGAATCTTGCTGGACTCAATTC	6413
	GAATTGAGTCCAGCAAGATTGCTAGACCCAATCTTATTGCCTTTTC CATTAGGATCAAGTCAAGAAGATGGTACAGGAAAGAATGACGACG TAGCAGAGGTGGCCACCATGACGAGGAGAT	6414
	ATCTTCTTGACTTGATC	6415
	GATCAAGTCAAGAAGAT	6416
15 Reduced palmitate Acyl-ACP-thioesterase <i>Arabidopsis thaliana</i> Gly22Term GGA-TGA	GTGGCCACCTCTGCTACGTCGTCATTCTTTCTGTACCATCTTCTT CACTTGATCCTAATTGAAAAGGCAATAAGATTGGGTCTACGAATCT TGCTGGACTCAATTCTGCACCTAACTCTG	6417
	CAGAGTTAGGTGCAGAATTGAGTCCAGCAAGATTCGTAGACCCAA TCTTATTGCCTTTTCAATTAGGATCAAGTGAAGAAGATGGTACAGG AAAGAATGACGACGTAGCAGAGGTGGCCAC	6418
	ATCCTAATTGAAAAGGC	6419
	GCCTTTTCAATTAGGAT	6420
20 Reduced palmitate Acyl-ACP-thioesterase <i>Garcinia mangostana</i> Ser8Term TCA-TGA	GCTTGAATTTGTGATCTGATTGGTTAATTGTGGCCACAATGGTTGC TACTGCCGCCACGTGATCATTCTTTCCGTTGACTTCCCCTTCTGGG GATGCCAAATCGGGCAATCCCGGAAAAGG	6421
	CCTTTTCCGGGATTGCCCGATTGGCATCCCCAGAAGGGGAAGTC AACGGAAAGAATGATCACGTGGCGGCAGTAGCAACCATTGTGGCC ACAATTAACCAATCAGATCACAAATTCAGC	6422
	CGCCACGTGATCATTCT	6423
	AGAATGATCACGTGGCG	6424

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced palmitate Acyl-ACP-thioesterase <i>Garcinia mangostana</i> Ser9Term TCA-TGA	TGAATTTGTGATCTGATTGGTTAATTGTGGCCACAATGGTTGCTAC TGCCGCCACGTCATGATTCTTTCCGTTGACTTCCCCTTCTGGGGAT GCCAAATCGGGCAATCCCGGAAAAGGGTC	6425
	GACCCTTTTCCGGGATTGCCCGATTGGCATCCCCAGAAGGGGAA GTCAACGGAAAGAATCATGACGTGGCGGCAGTAGCAACCATTGTG GCCACAATTAACCAATCAGATCACAAATTCA	6426
	CACGTCATGATTCTTTC	6427
	GAAAGAATCATGACGTG	6428
10 Reduced palmitate Acyl-ACP-thioesterase <i>Garcinia mangostana</i> Leu13Term TTG-TAG	CTGATTGGTTAATTGTGGCCACAATGGTTGCTACTGCCGCCACGT CATCATTCTTCCGTAGACTTCCCCTTCTGGGGATGCCAAATCGG GCAATCCCGGAAAAGGGTCGGTGAGTTTTGG	6429
	CCAAACTCACCGACCCTTTTCCGGGATTGCCCGATTGGCATCC CCAGAAGGGGAAGTCTACGGAAAGAATGATGACGTGGCGGCAGT AGCAACCATTGTGGCCACAATTAACCAATCAG	6430
	CTTCCGTAGACTTCCC	6431
	GGGAAGTCTACGGAAAG	6432
15 Reduced palmitate Acyl-ACP-thioesterase <i>Garcinia mangostana</i> Lys21Term AAA-TAA	ATGGTTGCTACTGCCGCCACGTCATCATTCTTCCGTTGACTTCCC CTTCTGGGGATGCCAATCGGGCAATCCCGGAAAAGGGTCGGTG AGTTTTGGGTCAATGAAGTCGAAATCCGCGG	6433
	CCGCGGATTCGACTTCATTGACCCAAAACCTCACCGACCCTTTTCC GGGATTGCCCGATTAGGCATCCCCAGAAGGGGAAGTCAACGGAA AGAATGATGACGTGGCGGCAGTAGCAACCAT	6434
	GGGATGCCAATCGGGC	6435
	GCCCGATTAGGCATCCC	6436
20 Reduced palmitate Acyl-ACP-thioesterase <i>Gossypium hirsutum</i> Ser8Term TCG-TAG	GGGATTCAGCACGAAATTGAAGTTGTTTTAAAAACCATGGTTGC TACTGCTGTGACATAGGCGTTTTTCCAGTCACTTCTTACCTGAC TCCTCTGACTCGAAAAACAAGAAGCTCGG	6437
	CCGAGCTTCTGTTTTTCGAGTCAGAGGAGTCAGGTGAAGAAGTG ACTGGGAAAAACGCCATATGTCACAGCAGTAGCAACCATGGTTTTTA AAAACAACCTCAATTCGTGCTGAAATCCC	6438
	TGTGACATAGGCGTTTT	6439
	AAAACGCCATATGTCACA	6440
25 Reduced palmitate Acyl-ACP-thioesterase <i>Gossypium hirsutum</i> Ser16Term TCA-TGA	TGTTTTTAAAAACCATGGTTGCTACTGCTGTGACATCGGCGTTTTT CCAGTCACTTCTTGACCTGACTCCTCTGACTCGAAAAACAAGAAG CTCGGAAGCATCAAGTCGAAGCCATCGGT	6441
	ACCGATGGCTTCGACTTGATGCTTCCGAGCTTCTTGTTTTTCGAGT CAGAGGAGTCAGGTCAAGAAGTGAAGTGGGAAAAACGCCGATGTCA CAGCAGTAGCAACCATGGTTTTTAAAAACA	6442

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CACTTCTTGACCTGACT	6443
	AGTCAGGTCAAGAAGTG	6444
5 Reduced palmitate Acyl-ACP-thioesterase <i>Gossypium hirsutum</i> Ser22Term TCG-TAG	TTGCTACTGCTGTGACATCGGCGTTTTTCCCAGTCACTTCTTCACC TGACTCCTCTGACTAGAAAAACAAGAAGCTCGGAAGCATCAAGTC GAAGCCATCGGTTTCTTCTGGAAGTTTGCA	6445
	TGCAAACCTCCAGAAGAAACCGATGGCTTCGACTTGATGCTTCCGA GCTTCTTGTTTTCTAGTCAGAGGAGTCAGGTGAAGAAGTGACTGG GAAAAACGCCGATGTCACAGCAGTAGCAA	6446
	CTCTGACTAGAAAAACA	6447
	TGTTTTCTAGTCAGAG	6448
10 Reduced palmitate Acyl-ACP-thioesterase <i>Gossypium hirsutum</i> Lys23Term AAA-TAA	GCTACTGCTGTGACATCGGCGTTTTTCCCAGTCACTTCTTCACCTG ACTCCTCTGACTCGTAAAACAAGAAGCTCGGAAGCATCAAGTCGA AGCCATCGGTTTCTTCTGGAAGTTTGCAAG	6449
	CTTGCAAACCTCCAGAAGAAACCGATGGCTTCGACTTGATGCTTCC GAGCTTCTTGTTTTACGAGTCAGAGGAGTCAGGTGAAGAAGTGAC TGGGAAAAACGCCGATGTCACAGCAGTAGC	6450
	CTGACTCGTAAAACAAG	6451
	CTTGTTTTACGAGTCAG	6452
15 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea hookeriana</i> Ser14Term TCG-TAG	CTCCCGCTCGTTGAAAGACAATGGTGGCTACCGCTGCAAGCTCTG CATTCTTCCCGTGTAGTCCCGGTACCTCCTCTAGACCAGGAA AGCCCGGAAATGGGTATCGAGCTTCAGCCC	6453
	GGGCTGAAGCTCGATGACCCATTTCCGGGCTTTCCTGGTCTAGAG GAGGTGACCGGGGACTACACGGGGAAGAATGCAGAGCTTGCAGC GGTAGCCACCATTGTCTTTCAACGAGCGGGAG	6454
	CCCCGTGTAGTCCCCGG	6455
	CCGGGGACTACACGGGG	6456
20 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea hookeriana</i> Arg21Term AGA-TGA	ATGGTGGCTACCGCTGCAAGCTCTGCATTCTTCCCGTGTCTGTCC CCGGTCACCTCCTCTGACCAGGAAAGCCCGGAAATGGGTATCG AGCTTCAGCCCCATCAAGCCCAAATTTGTCG	6457
	CGACAAATTTGGGCTTGATGGGGCTGAAGCTCGATGACCCATTTT CGGGCTTTCCTGGTCAAGAGGAGGTGACCGGGGACGACACGGG GAAGAATGCAGAGCTTGACGCGGTAGCCACCAT	6458
	CCTCCTCTGACCAGGA	6459
	TCCTGGTCAAGAGGAGG	6460

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea hookeriana</i> Gly23Term GGA-TGA	GCTACCGCTGCAAGCTCTGCATTCTTCCCCGTGTCGTCCCCGGTC ACCTCCTCTAGACCATGAAAGCCCGGAAATGGGTCATCGAGCTTC AGCCCCATCAAGCCCAAATTTGTCGCCAATG	6461
	CATTGGCGACAAATTTGGGCTTGATGGGGCTGAAGCTCGATGACC CATTTCCGGGCTTTCA T TGGTCTAGAGGAGGTGACCGGGGACGAC ACGGGGAAGAATGCAGAGCTTGCAGCGGTAGC	6462
	CTAGACCATGAAAGCCC	6463
	GGGCTTTCATGGTCTAG	6464
10 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea hookeriana</i> Lys24Term AAG-TAG	ACCGCTGCAAGCTCTGCATTCTTCCCCGTGTCGTCCCCGGTCACC TCCTCTAGACCAGGATAGCCCGGAAATGGGTCATCGAGCTTCAGC CCCATCAAGCCCAAATTTGTCGCCAATGGCG	6465
	CGCCATTGGCGACAAATTTGGGCTTGATGGGGCTGAAGCTCGATG ACCCATTTCCGGGCTATCCTGGTCTAGAGGAGGTGACCGGGGAC GACACGGGGAAGAATGCAGAGCTTGCAGCGGT	6466
	GACCAGGATAGCCCGGA	6467
	TCCGGGCTATCCTGGTC	6468
15 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea lanceolata</i> Gly23Term GGA-TGA	GCCACCGCTGCAAGTTCTGCATTCTTCCCCCTGCCGTCCCCGGAC ACCTCCTCTAGGCCGTGAAAGCTCGGAAATGGGTCATCGAGCTTG AGCCCCCTCAAGCCCAAATTTGTCGCCAATG	6469
	CATTGGCGACAAATTTGGGCTTGAGGGGGCTCAAGCTCGATGACC CATTTCCGAGCTTTCACGGCCTAGAGGAGGTGTCCGGGGACGGC AGGGGGAAGAATGCAGAACTTGCAGCGGTGGC	6470
	CTAGGCCGTGAAAGCTC	6471
	GAGCTTTCACGGCCTAG	6472
20 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea lanceolata</i> Lys24Term AAG-TAG	ACCGCTGCAAGTTCTGCATTCTTCCCCCTGCCGTCCCCGGACACC TCCTCTAGGCCGGGATAGCTCGGAAATGGGTCATCGAGCTTGAGC CCCCTCAAGCCCAAATTTGTCGCCAATGCCG	6473
	CGGCATTGGCGACAAATTTGGGCTTGAGGGGGCTCAAGCTCGAT GACCCATTTCCGAGCTATCCCGGCCTAGAGGAGGTGTCCGGGGA CGGCAGGGGGAAGAATGCAGAACTTGCAGCGGT	6474
	GGCCGGGATAGCTCGGA	6475
	TCCGAGCTATCCCGGCC	6476
25 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea lanceolata</i> Gly26Term GGA-TGA	GCAAGTTCTGCATTCTTCCCCCTGCCGTCCCCGGACACCTCCTCT AGGCCGGGAAAGCTCTGAAATGGGTCATCGAGCTTGAGCCCCCT CAAGCCCAAATTTGTCGCCAATGCCGGTTGA	6477
	TCAACCCGGCATTGGCGACAAATTTGGGCTTGAGGGGGCTCAAGC TCGATGACCCATTTCA G AGCTTTCCCGGCCTAGAGGAGGTGTCCG GGGACGGCAGGGGGAAGAATGCAGAACTTGC	6478

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GAAAGCTCTGAAATGGG	6479
	CCCATTTCAGAGCTTTC	6480
5 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea lanceolata</i> Ser29Term TCA-TGA	CATTCTTCCCCCTGCCGTCCCCGGACACCTCCTCTAGGCCGGGAA AGCTCGGAAATGGGTGATCGAGCTTGAGCCCCCTCAAGCCCAAAT TTGTCGCCAATGCCGGGTTGAAGGTTAAGGC	6481
	GCCTTAACCTTCAACCCGGCATTGGCGACAAATTTGGGCTTGAGG GGGCTCAAGCTCGATCACCATTTCGAGCTTCCCGGCCTAGAG GAGGTGTCCGGGGACGGCAGGGGGAAGAATG	6482
	AAATGGGTGATCGAGCT	6483
	AGCTCGATCACCATT	6484
10 Reduced palmitate Acyl-ACP-thioesterase <i>Helianthus annuus</i> Ser9Term TCG-TAG	CGTTAAGTGGATCGGACATTTAAGTGTTTTAATCATGGTAGCTAT GAGTGCTACTGCGTAGCTGTTTCCGGTTTCTTCCCCAAAACCTCA CTCTGGAGCCAAGACATCTGATAAGCTTGG	6485
	CCAAGCTTATCAGATGTCTTGGCTCCAGAGTGAGGTTTTGGGGAA GAAACCGGAAACAGCTACGCAGTAGCACTCATAGCTACCATGATT AAAACACTTAAATGTCCGATCCACTTAAACG	6486
	TACTGCGTAGCTGTTTC	6487
	GAAACAGCTACGCAGTA	6488
15 Reduced palmitate Acyl-ACP-thioesterase <i>Helianthus annuus</i> Lys17Term AAA-TAA	AGTGTTTTAATCATGGTAGCTATGAGTGCTACTGCGTCGCTGTTTC CGGTTTCTTCCCCATAACCTCACTCTGGAGCCAAGACATCTGATAA GCTTGGAGGTGAACCAGGTAGTGTTGCTG	6489
	CAGCAACACTACCTGGTTCACCTCCAAGCTTATCAGATGTCTTGGC TCCAGAGTGAGGTTATGGGGAAGAAACCGGAAACAGCGACGCAG TAGCACTCATAGCTACCATGATTAAACACT	6490
	CTTCCCCATAACCTCAC	6491
	GTGAGGTTATGGGGAAG	6492
20 Reduced palmitate Acyl-ACP-thioesterase <i>Helianthus annuus</i> Gly21Term GGA-TGA	ATGGTAGCTATGAGTGCTACTGCGTCGCTGTTTCCGGTTTCTTCCC CAAAACCTCACTCTTGAGCCAAGACATCTGATAAGCTTGGAGGTGA ACCAGGTAGTGTTGCTGTGCGCGGAATCA	6493
	TGATTCCGCGCACAGCAACACTACCTGGTTCACCTCCAAGCTTATC AGATGTCTTGGCTCAAGAGTGAGGTTTTGGGGAAGAAACCGGAAA CAGCGACGCAGTAGCACTCATAGCTACCAT	6494
	CTCACTCTTGAGCCAAG	6495
	CTTGGCTCAAGAGTGAG	6496

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced palmitate Acyl-ACP-thioesterase <i>Helianthus annuus</i> Lys23Term AAG-TAG	GCTATGAGTGCTACTGCGTCGCTGTTCCGGTTTCTTCCCCAAAAC CTCACTCTGGAGCCTAGACATCTGATAAGCTTGGAGGTGAACCAG GTAGTGTGCTGTGCGCGGAATCAAGACAA	6497
	TTGTCTTGATTCCGCGCACAGCAACACTACCTGGTTCACCTCCAAG CTTATCAGATGTCTAGGCTCCAGAGTGAGGTTTTGGGGAAGAAAC CGGAAACAGCGACGCAGTAGCACTCATAGC	6498
	CTGGAGCCTAGACATCT	6499
	AGATGTCTAGGCTCCAG	6500
10 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea palustris</i> Lys21Term AAA-TAA	ATGGTGGCTGCTGCAGCAAGTTCTGCATGCTTCCCTGTTCCATCC CCAGGAGCCTCCCCTTAACCTGGGAAGTTAGGCAACTGGTCATCG AGTTTGAGCCCTTCCTTGAAGCCCAAGTCAA	6501
	TTGACTTGGGCTTCAAGGAAGGGCTCAAACCTCGATGACCAGTTGC CTAACTCCCAGGTTAAGGGGAGGCTCCTGGGGATGGAACAGGG AAGCATGCAGAACTTGCTGCAGCAGCCACCAT	6502
	CCTCCCCTTAACCTGGG	6503
	CCCAGGTTAAGGGGAGG	6504
15 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea palustris</i> Lys24Term AAG-TAG	GCTGCAGCAAGTTCTGCATGCTTCCCTGTTCCATCCCCAGGAGCC TCCCCTAAACCTGGGTAAGTTAGGCAACTGGTCATCGAGTTTGAGC CCTTCCTTGAAGCCCAAGTCAATCCCCAATG	6505
	CATTGGGGATTGACTTGGGCTTCAAGGAAGGGCTCAAACCTCGATG ACCAGTTGCCTAACTACCCAGGTTTAGGGGAGGCTCCTGGGGATG GAACAGGGAAGCATGCAGAACTTGCTGCAGC	6506
	AACCTGGGTAGTTAGGC	6507
	GCCTAACTACCCAGGTT	6508
20 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea palustris</i> Trp28Term TGG-TGA	TGCATGCTTCCCTGTTCCATCCCAGGAGCCTCCCCTAAACCTGG GAAGTTAGGCAACTGATCATCGAGTTTGAGCCCTTCCTTGAAGCC CAAGTCAATCCCCAATGGCGGATTTAGGTT	6509
	AACCTGAAATCCGCCATTGGGGATTGACTTGGGCTTCAAGGAAGG GCTCAAACCTCGATGATCAGTTGCCTAACTTCCCAGGTTTAGGGGA GGCTCCTGGGGATGGAACAGGGAAGCATGCA	6510
	GGCAACTGATCATCGAG	6511
	CTCGATGATCAGTTGCC	6512
25 Reduced palmitate Acyl-ACP-thioesterase <i>Cuphea palustris</i> Ser29Term TCA-TGA	CATGCTTCCCTGTTCCATCCCAGGAGCCTCCCCTAAACCTGGGA AGTTAGGCAACTGGTGATCGAGTTTGAGCCCTTCCTTGAAGCCCA AGTCAATCCCCAATGGCGGATTTAGGTTAA	6513
	TTAACCTGAAATCCGCCATTGGGGATTGACTTGGGCTTCAAGGAA GGGCTCAAACCTCGATCACCAGTTGCCTAACTTCCCAGGTTTAGGG GAGGCTCCTGGGGATGGAACAGGGAAGCATG	6514

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	CAACTGGT <u>G</u> ATCGAGTT	6515
	AACTCGAT <u>C</u> ACCAGTTG	6516
	ATGGTGGCTGCCGAGCAAGTTCTGCATTCTTCTCCGTTCCAACC CCGGGAATCTCCCCTTAACCCGGGAAGTTCGGTAATGGTGGCTTT CAGGTTAAGGCAAACGCCAATGCCCATCCTA	6517
	TAGGATGGGCATTGGCGTTTGCCTTAACCTGAAAGCCACCATTAC CGAACTTCCCGGGTTAAGGGGAGATTCCCGGGGTGGAACGGAG AAGAATGCAGAACTTGCTGCGGCAGCCACCAT	6518
	TCTCCCCTTAACCCGGG	6519
10	CCCGGGTTAAGGGGAGA	6520
	GCCGAGCAAGTTCTGCATTCTTCTCCGTTCCAACCCCGGGAATC TCCCCTAAACCCGGGTAGTTCGGTAATGGTGGCTTTCAGGTTAAG GCAAACGCCAATGCCCATCCTAGTCTAAAGT	6521
	ACTTTAGACTAGGATGGGCATTGGCGTTTGCCTTAACCTGAAAGCC ACCATTACCGAACTACCCGGGTTTAGGGGAGATTCCCGGGGTGG AACGGAGAAGAATGCAGAACTTGCTGCGGC	6522
	AACCCGGGTAGTTCGGT	6523
	ACCGAACTACCCGGGTT	6524
15	TTCTCCGTTCCAACCCCGGGAATCTCCCCTAAACCCGGGAAGTTC GGTAATGGTGGCTTTTAGGTTAAGGCAAACGCCAATGCCCATCCT AGTCTAAAGTCTGGCAGCCTCGAGACTGAAG	6525
	CTTCAGTCTCGAGGCTGCCAGACTTTAGACTAGGATGGGCATTGG CGTTTGCCTTAACCTAAAAGCCACCATTACCGAACTTCCCGGGTTT AGGGGAGATTCCCGGGGTGGAACGGAGAA	6526
	GTGGCTTTTAGGTTAAG	6527
	CTTAACCTAAAAGCCAC	6528
20	GTTCCAACCCCGGGAATCTCCCCTAAACCCGGGAAGTTCGGTAAT GGTGGCTTTCAGGTTTAGGCAAACGCCAATGCCCATCCTAGTCTA AAGTCTGGCAGCCTCGAGACTGAAGATGACA	6529
	TGTCATCTTCAGTCTCGAGGCTGCCAGACTTTAGACTAGGATGGG CATTGGCGTTTGCCTAACCTGAAAGCCACCATTACCGAACTTCCC GGGTTTAGGGGAGATTCCCGGGGTGGAAC	6530
	TTCAGGTTTAGGCAAAC	6531
	GTTTGCCTAACCTGAA	6532

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica rapa</i> Gln21Term CAA-TAA	ATGTTGAAGCTCTCGTGTAAATGCGACTGATAAGTTACAGACCCTCT TCTCGCATTCTCATTAACCGGATCCGGCACACCGGAGAACCGTCT CCTCCGTGTCGTGCTCTCATCTGAGGAAAC	6533
	GTTTCCTCAGATGAGAGCACGACACGGAGGAGACGGTTCTCCGGT GTGCCGGATCCGGTTAATGAGAATGCGAGAAGAGGGTCTGTAAC TATCAGTCGCATTACACGAGAGCTTCAACAT	6534
	ATTCTCATTAACCGGAT	6535
	ATCCGGTTAATGAGAAT	6536
10 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica rapa</i> Arg28Term AGA-TGA	GCGACTGATAAGTTACAGACCCTCTTCTCGCATTCTCATCAACCGG ATCCGGCACACCGGTGAACCGTCTCCTCCGTGTCGTGCTCTCATC TGAGGAAACCGGTTCTCGATCCTTTGCGAG	6537
	CTCGCAAAGGATCGAGAACCGGTTTCTCAGATGAGAGCACGACA CGGAGGAGACGGTTCAACCGGTGTGCCGGATCCGGTTGATGAGAA TGCGAGAAGAGGGTCTGTAACCTTATCAGTCGC	6538
	CACACCGGTGAACCGTC	6539
	GACGGTTCACCGGTGTG	6540
15 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica rapa</i> Ser24Term TCG-TAG	CCCTCTTCTCGCATTCTCATCAACCGGATCCGGCACACCGGAGAA CCGTCTCCTCCGTGTAGTGCTCTCATCTGAGGAAACCGGTTCTCG ATCCTTTGCGAGCGATCGTATCTGCTGATCA	6541
	TGATCAGCAGATACGATCGCTCGCAAAGGATCGAGAACCGGTTTC CTCAGATGAGAGCACTACACGGAGGAGACGGTTCTCCGGTGTGC CGGATCCGGTTGATGAGAATGCGAGAAGAGGG	6542
	CTCCGTGTAGTGCTCTC	6543
	GAGAGCACTACACGGAG	6544
20 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica rapa</i> Cys25Term TGC-TGA	CTTCTCGCATTCTCATCAACCGGATCCGGCACACCGGAGAACCGT CTCCTCCGTGTCGTGATCTCATCTGAGGAAACCGGTTCTCGATCC TTTGCAGCGATCGTATCTGCTGATCAAGGA	6545
	TCCTTGATCAGCAGATACGATCGCTCGCAAAGGATCGAGAACCGG TTTCCTCAGATGAGATCACGACACGGAGGAGACGGTTCTCCGGTG TGCCGGATCCGGTTGATGAGAATGCGAGAAG	6546
	GTGTCGTGATCTCATCT	6547
	AGATGAGATCACGACAC	6548
25 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica napus</i> Leu2Term TTG-TAG	ATTCTTCTTCTATAAACCAAAACCTCAGGAACCATAAAAAAAAAAGG GCATCAAAAATGTAGAAGCTTTCGTGTAATGTGACTAACAACCTTAC ACACCTTCTCCTTCTTCTCCGATTCTC	6549
	GAGGAATCGGAGAAGAAGGAGAAGGTGTGTAAGTTGTTAGTCACA TTACACGAAAGCTTCTACATTTTTGATGCCCTTTTTTTTTATGGTTC CTGAGGTTTTGGTTATAGAAGAAGAAT	6550

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	AAAAATGT <u>A</u> GAAGCTTT	6551
	AAAGCTTC <u>T</u> ACATTTTT	6552
5 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica napus</i> Lys3Term AAG-TAG	TCTTCTTCTATAAACCAAAACCTCAGGAACCATAAAAAAAAAAAGGG CATCAAAAATGTTG <u>T</u> AGCTTTTCGTGTAATGTGACTAACAACTTACAC ACCTTCTCCTTCTTCTCCGATTCTCC	6553
	GGGAGGAATCGGAGAAGAAGGAGAAGGTGTGTAAGTTGTTAGTCA CATTACACGAAAGCT <u>A</u> CAACATTTTTGATGCCCTTTTTTTTTATGG TTCCTGAGGTTTTGGTTTATAGAAGAAGA	6554
	AAATGTTG <u>I</u> AGCTTTCCG	6555
	CGAAAGCT <u>A</u> CAACATTT	6556
10 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica napus</i> Ser5Term TCG-TAG	CTATAAACCAAAACCTCAGGAACCATAAAAAAAAAAAGGGCATCAAA AATGTTGAAGCTTT <u>A</u> GTGTAATGTGACTAACAACTTACACACCTTCT CCTTCTTCTCCGATTCTCCCTTTTCAT	6557
	ATGAAAAGGGAGGAATCGGAGAAGAAGGAGAAGGTGTGTAAGTTG TTAGTCACATTACAC <u>I</u> AAAGCTTCAACATTTTTGATGCCCTTTTTTTT TTATGGTTCCTGAGGTTTTGGTTTATAG	6558
	GAAGCTTT <u>A</u> GTGTAATG	6559
	CATTACAC <u>I</u> AAAGCTTC	6560
15 Reduced palmitate Acyl-ACP-thioesterase <i>Brassica napus</i> Cys6Term TGT-TGA	AAACCAAAACCTCAGGAACCATAAAAAAAAAAAGGGCATCAAAAATG TTGAAGCTTTTCGTG <u>A</u> AATGTGACTAACAACTTACACACCTTCTCCTT CTTCTCCGATTCTCCCTTTTCATCCCG	6561
	CGGGATGAAAAGGGAGGAATCGGAGAAGAAGGAGAAGGTGTGTA AGTTGTTAGTCACATT <u>I</u> CACGAAAGCTTCAACATTTTTGATGCCCTT TTTTTTTTATGGTTCCTGAGGTTTTGGTTT	6562
	CTTTCGTG <u>A</u> AATGTGAC	6563
	GTCACATT <u>I</u> CACGAAAG	6564

Table 23
Oligonucleotides to produce plants with increased stearate

	Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	Increased stearate stearoyl-ACP desaturase <i>Arabidopsis thaliana</i> Lys4Term AAG-TAG	GGGAGAGCTCTAGCTCTGTAGAAAAGAAGGATTCATTCATCATATC CAGAAATGGCTCTATAGTTTAACCCCTTGGTGGCATCTCAGCCTTA CAAATTCCTTCCTCGACTCGTCCGCCAA	6565
10		TTGGCGGACGAGTCGAGGAAGGGAATTTGTAAGGCTGAGATGCCA CCAAAGGGTTAAACTATAGAGCCATTTCTGGATATGATGAATGAAT CCTTCTTTCTACAGAGCTAGAGCTCTCCC	6566
		TGGCTCTATAGTTTAAC	6567
		GTAAACTATAGAGCCA	6568
15	Increased stearate stearoyl-ACP desaturase <i>Arabidopsis thaliana</i> Leu8Term TTG-TAG	CTCTGTAGAAAAGAAGGATTCATTCATCATATCCAGAAATGGCTCT AAAGTTTAACCCCTTAGGTGGCATCTCAGCCTTACAAATTCCTTCC TCGACTCGTCCGCCAACTCCTTCTTTCAG	6569
		CTGAAAGAAGGAGTTGGCGGACGAGTCGAGGAAGGGAATTTGTAA GGCTGAGATGCCACCTAAGGGTTAACTTTAGAGCCATTTCTGGAT ATGATGAATGAATCCTTCTTTCTACAGAG	6570
		TAACCCCTTAGGTGGCAT	6571
		ATGCCACCTAAGGGTTA	6572
20	Increased stearate stearoyl-ACP desaturase <i>Arabidopsis thaliana</i> Gln12Term CAG-TAG	AGAAGGATTCATTCATCATATCCAGAAATGGCTCTAAAGTTTAACC CTTTGGTGGCATCTTAGCCTTACAAATTCCTTCCTCGACTCGTCC GCCAACTCCTTCTTTCAGATCTCCCAAGT	6573
		ACTTGGGAGATCTGAAAGAAGGAGTTGGCGGACGAGTCGAGGAA GGGAATTTGTAAGGCTAAGATGCCACCAAAGGGTTAACTTTAGAG CCATTTCTGGATATGATGAATGAATCCTTCT	6574
		TGGCATCTTAGCCTTAC	6575
		GTAAGGCTAAGATGCCA	6576
25	Increased stearate stearoyl-ACP desaturase <i>Arabidopsis thaliana</i> Phe14Term TAC-TAG	TCATTCATCATATCCAGAAATGGCTCTAAAGTTTAACCCCTTGGTG GCATCTCAGCCTTAGAAATTCCTTCCTCGACTCGTCCGCCAACTC CTTCTTTCAGATCTCCCAAGTTCTCTGC	6577
		GCAGAGGAACCTGGGAGATCTGAAAGAAGGAGTTGGCGGACGAG TCGAGGAAGGGAATTTCTAAGGCTGAGATGCCACCAAAGGGTTAA ACTTTAGAGCCATTTCTGGATATGATGAATGA	6578
		CAGCCTTAGAAATTCCC	6579
		GGGAATTTCTAAGGCTG	6580

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Increased stearate stearoyl-ACP desaturase <i>Brassica napus</i> Leu3Term TTG-TAG	GAGAGCTCGCTCGTGTCTGAAAGAACATCAAACCTCGTATCAAAAA AAAGAAAATGGCATAGAAGCTTAACCCTTTGGCATCTCAGCCTTAC AAACTCCCTTCCTCGGCTCGTCCGCCAAT	6581
	ATTGGCGGACGAGCCGAGGAAGGGAGTTTGTAAGGCTGAGATGC CAAAGGGTTAAGCTTCTATGCCATTTTCTTTTTTTGATACGAGGTT TGATGTTCTTTCAGACACGAGCGAGCTCTC	6582
	AATGGCATAGAAGCTTA	6583
	TAAGCTTCTATGCCATT	6584
10 Increased stearate stearoyl-ACP desaturase <i>Brassica napus</i> Lys4Term AAG-TAG	GAGCTCGCTCGTGTCTGAAAGAACATCAAACCTCGTATCAAAAAA AGAAAATGGCATTGTAGCTTAACCCTTTGGCATCTCAGCCTTACAA ACTCCCTTCCTCGGCTCGTCCGCCAATCT	6585
	AGATTGGCGGACGAGCCGAGGAAGGGAGTTTGTAAGGCTGAGAT GCCAAAGGGTTAAGCTACAATGCCATTTTCTTTTTTTGATACGAG GTTTGATGTTCTTTCAGACACGAGCGAGCTC	6586
	TGGCATTGTAGCTTAAC	6587
	GTTAAGCTACAATGCCA	6588
15 Increased stearate stearoyl-ACP desaturase <i>Brassica napus</i> Leu8Term TTG-TAG	TCTGAAAGAACATCAAACCTCGTATCAAAAAAAGAAAATGGCATT GAAGCTTAACCCTTAGGCATCTCAGCCTTACAACTCCCTTCCTCG GCTCGTCCGCCAATCTCTACTCTCAGATC	6589
	GATCTGAGAGTAGAGATTGGCGGACGAGCCGAGGAAGGGAGTTT GTAAGGCTGAGATGCCAAGGGTTAAGCTTCAATGCCATTTTCTTT TTTTTGATACGAGGTTTGATGTTCTTTCAGA	6590
	TAACCCTTAGGCATCTC	6591
	GAGATGCCAAGGGTTA	6592
20 Increased stearate stearoyl-ACP desaturase <i>Brassica napus</i> Gln11Term CAG-TAG	AACATCAAACCTCGTATCAAAAAAAGAAAATGGCATTGAAGCTTAA CCCTTTGGCATCTTAGCCTTACAACTCCCTTCCTCGGCTCGTCCG CCAATCTCTACTCTCAGATCTCCCAAGT	6593
	ACTTGGGAGATCTGAGAGTAGAGATTGGCGGACGAGCCGAGGAA GGGAGTTTGTAAGGCTAAGATGCCAAGGGTTAAGCTTCAATGCC ATTTTCTTTTTTTGATACGAGGTTTGATGTT	6594
	TGGCATCTTAGCCTTAC	6595
	GTAAGGCTAAGATGCCA	6596
25 Increased stearate stearoyl-ACP desaturase <i>Ricinus communis</i> Gln27Term CAA-TAA	AACCAAAAGAAAAGGTAAGAAAAAACAATGGCTCTCAAGCTCA ATCCTTTCTTTTCTTAACCCAAAAGTTACCTTCTTCGCTCTTCCA CCAATGGCCAGTACCAGATCTCCTAAGT	6597
	ACTTAGGAGATCTGGTACTGGCCATTGGTGGAAGAGCGAAAGAAG GTAACTTTTGGGTTTAAGAAAGGAAAGGATTGAGCTTGAGAGCCAT TGTTTTTTTCTTACCTTTTTCTTTTGTT	6598

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TCCTTTCTTAAACCCAA	6599
	TTGGGTTTAAAGAAAGGA	6600
Increased stearate stearoyl-ACP desaturase <i>Ricinus communis</i> Gln29Term CAA-TAA	AAGAAAAAGGTAAGAAAAAACAATGGCTCTCAAGCTCAATCCTT TCCTTTCTCAAACCTAAAGTTACCTTCTTCGCTCTTCCACCAATG GCCAGTACCAGATCTCCTAAGTTCTACA	6601
	TGTAGAACTTAGGAGATCTGGTACTGGCCATTGGTGGAAAGAGCGA AAGAAGGTAACTTTTAGGTTTGAGAAAGGAAAGGATTGAGCTTGAG AGCCATTGTTTTTTTCTTACCTTTTTCTT	6602
	CTCAAACCTAAAGTTA	6603
	TAACTTTTAGGTTTGAG	6604
Increased stearate stearoyl-ACP desaturase <i>Ricinus communis</i> Lys30Term AAG-TAG	AAAAAGGTAAGAAAAAACAATGGCTCTCAAGCTCAATCCTTTCC TTTCTCAAACCCAATAGTTACCTTCTTCGCTCTTCCACCAATGGC CAGTACCAGATCTCCTAAGTTCTACATGG	6605
	CCATGTAGAACTTAGGAGATCTGGTACTGGCCATTGGTGGAAAGAG CGAAAGAAGGTAACCTATTGGGTTTGAGAAAGGAAAGGATTGAGCT TGAGAGCCATTGTTTTTTTCTTACCTTTTT	6606
	AAACCCAATAGTTACCT	6607
	AGGTAACCTATTGGGTTT	6608
Increased stearate stearoyl-ACP desaturase <i>Ricinus communis</i> Lys46Term AAG-TAG	TCTCAAACCCAAAAGTTACCTTCTTCGCTCTTCCACCAATGGCCA GTACCAGATCTCCTTAGTTCTACATGGCCTCTACCCTCAAGTCTGG TTCTAAGGAAGTTGAGAATCTCAAGAAGC	6609
	GCTTCTTGAGATTCTCAACTTCCTTAGAACCAGACTTGAGGGTAGA GGCCATGTAGAACTAAGGAGATCTGGTACTGGCCATTGGTGGAAAG AGCGAAAGAAGGTAACCTTTGGGTTTGAGA	6610
	GATCTCCTTAGTTCTAC	6611
	GTAGAACTAAGGAGATC	6612
Increased stearate stearoyl-ACP desaturase <i>Glycine max</i> Gln11Term CAA-TAA	TCTTCTGATTCATTTAATCTTACTCATCAATGGCTCTGAGACTGAA CCCTATCCCCACCTAAACCTTCTCCCTCCCCCAAATGGCCAGTCT CAGATCTCCCAGGTTCCGCATGGCCTCTA	6613
	TAGAGGCCATGCGGAACCTGGGAGATCTGAGACTGGCCATTTGG GGGAGGGAGAAGGTTTAGGTGGGGATAGGGTTCAGTCTCAGAGC CATTGATGAGTAAAGATTAAATGAATCAGAAGA	6614
	TCCCCACCTAAACCTTC	6615
	GAAGGTTTAGGTGGGGA	6616

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Increased stearate stearoyl-ACP desaturase <i>Glycine max</i> Gln17Term CAA-TAA	CTTTACTCATCAATGGCTCTGAGACTGAACCCTATCCCCACCCAAA CCTTCTCCCTCCCCTAAATGGCCAGTCTCAGATCTCCCAGGTTCC GCATGGCCTCTACCCCTCCGCTCCGGTTCCA	6617
	TGGAACCGGAGCGGAGGGTAGAGGCCATGCGGAACCTGGGAGAT CTGAGACTGGCCATTTAGGGGAGGGAGAAGGTTTGGGTGGGGAT AGGGTTCACTCTCAGAGCCATTGATGAGTAAAG	6618
	CCCTCCCCCTAAATGGCC	6619
	GGCCATTTAGGGGAGGG	6620
10 Increased stearate stearoyl-ACP desaturase <i>Glycine max</i> Arg22Term AGA-TGA	GCTCTGAGACTGAACCCTATCCCCACCCAAACCTTCTCCCTCCCC CAAATGGCCAGTCTCTGATCTCCCAGGTTCCGCATGGCCTCTACC CTCCGCTCCGGTTCCAAAGAGGTTGAAAATA	6621
	TATTTTCAACCTCTTTGGAACCGGAGCGGAGGGTAGAGGCCATGC GGAACCTGGGAGATCAGAGACTGGCCATTTGGGGGAGGGAGAAG GTTTGGGTGGGGATAGGGTTCAGTCTCAGAGC	6622
	CCAGTCTCTGATCTCCC	6623
	GGGAGATCAGAGACTGG	6624
15 Increased stearate stearoyl-ACP desaturase <i>Glycine max</i> Lys37Term AAA-TAA	CAAATGGCCAGTCTCAGATCTCCCAGGTTCCGCATGGCCTCTACC CTCCGCTCCGGTTCCCTAAGAGGTTGAAAATATTAAGAAGCCATTCA CTCCTCCCAGAGAAGTGCATGTTCAAGTAA	6625
	TACTTTGAACATGCACTTCTCTGGGAGGAGTGAATGGCTTCTTAAT ATTTTCAACCTCTTAGGAACCGGAGCGGAGGGTAGAGGCCATGCG GAACCTGGGAGATCTGAGACTGGCCATTTG	6626
	CCGGTTCCCTAAGAGGTT	6627
	AACCTCTTAGGAACCGG	6628
20 Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Gln11Term CAA-TAA	CAACAAGCACACACAAGAACAACATCAACAATGGCGATTTCGCATCA ATACGGCGACGTTTAAATCAGACCTGTACCGTTCATTTCGCGTTTCC TCAACCGAAACCTCTCAGATCTCCCAAAT	6629
	ATTTGGGAGATCTGAGAGGTTTCGGTTGAGGAAACGCGAATGAAC GGTACAGGTCTGATTAAACGTCGCCGTATTGATGCGAATCGCCA TTGTTGATGTTGTTCTTGTGTGTGCTTGTG	6630
	CGACGTTTAAATCAGAC	6631
	GTCTGATTAAACGTCG	6632
25 Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Ser12Term TCA-TGA	AAGCACACACAAGAACAACATCAACAATGGCGATTTCGCATCAATAC GGCGACGTTTCAATGAGACCTGTACCGTTCATTTCGCGTTTCTCAA CCGAAACCTCTCAGATCTCCCAAATTCGC	6633
	GCGAATTTGGGAGATCTGAGAGGTTTCGGTTGAGGAAACGCGAAT GAACGGTACAGGTCTCATTGAAACGTCGCCGTATTGATGCGAATC GCCATTGTTGATGTTGTTCTTGTGTGTGCTT	6634

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GTTTCAATGAGACCTGT	6635
	ACAGGTCTCATTGAAAC	6636
Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Tyr15Term TAC-TAG	AAGAACAACATCAACAATGGCGATTTCGCATCAATACGGCGACGTTT CAATCAGACCTGTAGCGTTTCATTTCGCGTTTCCTCAACCGAAACCTC TCAGATCTCCCAAATTCGCCATGGCTTCC	6637
	GGAAGCCATGGCGAATTTGGGAGATCTGAGAGGTTTCGGTTGAGG AAACGCGAATGAACGCTACAGGTCTGATTGAAACGTCGCCGTATT GATGCGAATCGCCATTGTTGATGTTGTTCTT	6638
	GACCTGTAGCGTTCATT	6639
	AATGAACGCTACAGGTC	6640
Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Ser17Term TCA-TGA	CAACATCAACAATGGCGATTTCGCATCAATACGGCGACGTTTCAATC AGACCTGTACCGTTGATTTCGCGTTTCCTCAACCGAAACCTCTCAGA TCTCCCAAATTCGCCATGGCTTCCACCAT	6641
	ATGGTGGAAGCCATGGCGAATTTGGGAGATCTGAGAGGTTTCGGT TGAGGAAACGCGAATCAACGGTACAGGTCTGATTGAAACGTCGCC GTATTGATGCGAATCGCCATTGTTGATGTTG	6642
	GTACCGTTGATTTCGCGT	6643
	ACGCGAATCAACGGTAC	6644
Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Arg4Term CGA-TGA	ACACACAACACACACTCAATCACACACACATCATCATCTTCTTCATC AACGATGGCGCTTIGAATGAGTCCGGTGACGTTCAACGGGAGAT ATATCCTTCATACACTTTTCATCAATCGA	6645
	TCGATTGATGAAAAGTGTATGAAGGATATATCTCCCGTTGAAGCGT CACCGGACTCATTCAAAGCGCCATCGTTGATGAAGAAGATGATGA TGTGTGTGTGATTGAGTGTGTGTTGTGTGT	6646
	TGGCGCTTIGAATGAGT	6647
	ACTCATTCAAAGCGCCA	6648
Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Gln11Term CAA-TAA	ACACACACATCATCATCTTCTTCATCAACGATGGCGCTTCGAATGA GTCCGGTGACGCTTAAACGGGAGATATATCCTTCATACACTTTTCA TCAATCGAAAAATCTCAGATCTCCTAAAT	6649
	ATTTAGGAGATCTGAGATTTTCGATTGATGAAAAGTGTATGAAGG ATATATCTCCCGTTAAAGCGTCACCGGACTCATTGAAGCGCCAT CGTTGATGAAGAAGATGATGATGTGTGTGT	6650
	TGACGCTTAAACGGGAG	6651
	CTCCCGTTAAAGCGTCA	6652

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
5 Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Glu13Term GAG-TAG	ACATCATCATCTTCTTCATCAACGATGGCGCTTCGAATGAGTCCGG TGACGCTTCAACGGTAGATATATCCTTCATACACTTTTCATCAATCG AAAAATCTCAGATCTCCTAAATTCGCGA	6653
	TCGCGAATTTAGGAGATCTGAGATTTTCGATTGATGAAAAGTGTA TGAAGGATATATCTACCGTTGAAGCGTCACCGGACTCATTGGAAG CGCCATCGTTGATGAAGAAGATGATGATGT	6654
	TTCAACGGTAGATATAT	6655
	ATATATCTACCGTTGAA	6656
10 Increased stearate stearoyl-ACP desaturase <i>Helianthus annuus</i> Tyr15Term TAT-TAG	ATCTTCTTCATCAACGATGGCGCTTCGAATGAGTCCGGTGACGCTT CAACGGGAGATATAGCCTTCATACACTTTTCATCAATCGAAAAATCT CAGATCTCCTAAATTCGCGATGGCTTCC	6657
	GGAAGCCATCGCGAATTTAGGAGATCTGAGATTTTCGATTGATGA AAAGTGTATGAAGGCTATATCTCCCGTTGAAGCGTCACCGGACTC ATTGGAAGCGCCATCGTTGATGAAGAAGAT	6658
	GAGATATAGCCTTCATA	6659
	TATGAAGGCTATATCTC	6660
15 Increased stearate stearoyl-ACP desaturase <i>Linum usitatissimum</i> Lys4Term AAG-TAG	AACTCAGCCAGCTTGCCCCCAAACAACAGCGCAGAAAAACCTTCA ACAACAATGGCTCTCTAGCTCAACCCAGTCACCACCTTCCCTTCAA CACGCTCCCTCAACAACCTTCTCCTCCAGAT	6661
	ATCTGGAGGAGAAGTTGTTGAGGGAGCGTGTTGAAGGGAAGGTG GTGACTGGGTTGAGCTAGAGAGCCATTGTTGTTGAAGGTTTTCTG CGCTGTTGTTTGGGGCAAGCTGGCTGAGTT	6662
	TGGCTCTCTAGCTCAAC	6663
	GTTGAGCTAGAGAGCCA	6664
20 Increased stearate stearoyl-ACP desaturase <i>Linum usitatissimum</i> Ser13Term TCA-TGA	GCGCAGAAAAACCTTCAACAACAATGGCTCTCAAGCTCAACCCAG TCACCACCTTCCCTTGAACACGCTCCCTCAACAACCTTCTCCTCCAG ATCTCCTCGCACCTTTCTCATGGCTGCTTC	6665
	GAAGCAGCCATGAGAAAGGTGCGAGGAGATCTGGAGGAGAAGTT GTTGAGGGAGCGTGTTCAAGGGAAGGTGGTGACTGGGTTGAGCT TGAGAGCCATTGTTGTTGAAGGTTTTCTGCGC	6666
	CTTCCCTTGAACACGCT	6667
	AGCGTGTTCAAGGGAAG	6668
25 Increased stearate stearoyl-ACP desaturase <i>Linum usitatissimum</i> Arg23Term AGA-TGA	CTCAAGCTCAACCCAGTCACCACCTTCCCTTCAACACGCTCCCTC AACAACCTTCTCCTCTGATCTCCTCGCACCTTTCTCATGGCTGCTT CCACTTTCAATTCCACCTCCACCAAGTAAG	6669
	CTTACTTGGTGGAGGTGGAATTGAAAGTGGAAGCAGCCATGAGAA AGGTGCGAGGAGATCAGGAGGAGAAGTTGTTGAGGGAGCGTGTT GAAGGGAAGGTGGTGACTGGGTTGAGCTTGAG	6670

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	TCTCCTCC <u>I</u> GATCTCCT	6671
	AGGAGATC <u>A</u> GGAGGAGA	6672
5 Increased stearate stearoyl-ACP desaturase <i>Linum usitatissimum</i> Lys41Term AAG-TAG	TCCTCCAGATCTCCTCGCACCTTTCTCATGGCTGCTTCCACTTTCA ATTCCACCTCCACCTAGTAAGCATCTCCTCCTCCTCGGAATCTCCG CCGATTTCTTTTAAGCGATTGATCGTAGA	6673
	TCTACGATCAATCGCTTAAAAAGAAATCGGCGGAGATTCCGAGGAG GAGGAGATGCTTACTAGGTGGAGGTGGAATTGAAAGTGGAAGCAG CCATGAGAAAGGTGCGAGGAGATCTGGAGGA	6674
	CCTCCACCTAGTAAGCA	6675
	TGCTTACTAGGTGGAGG	6676
10 Increased stearate stearoyl-ACP desaturase <i>Olea europaea</i> Arg21Term AGA-TGA	ATGGCACTGAAACTTTGCTTTCCACCCCACAAGATGCCTTCCTTCC CCGATGCTCGTATC <u>I</u> GATCTCACAGGGTTTTCATGGCTTCAACTAT TCATTCTCCTTCTATGGAGGTCGGAAAAG	6677
	CTTTTCCGACCTCCATAGAAGGAGAATGAATAGTTGAAGCCATGAA AACCCGTGAGATCAGATACGAGCATCGGGGAAGGAAGGCATCTT GTGGGGTGGAAGCAAAGTTTCAGTGCCAT	6678
	CTCGTATC <u>I</u> GATCTCAC	6679
	GTGAGATCAGATACGAG	6680
15 Increased stearate stearoyl-ACP desaturase <i>Olea europaea</i> Ser29Term TCA-TGA	CCCACAAGATGCCTTCCTTCCCCGATGCTCGTATCAGATCTCACA GGGTTTTTCATGGCTTGA <u>A</u> CTATTCACTCTCCTTCTATGGAGGTCGG AAAAGTTAAAAAGCCTTTCACGCCTCCACG	6681
	CGTGGAGGCGTGAAAGGCTTTTAACTTTTCCGACCTCCATAGAAG GAGAATGAATAGTTCAAGCCATGAAAACCCTGTGAGATCTGATACG AGCATCGGGGAAGGAAGGCATCTTGTGGG	6682
	CATGGCTTGA <u>A</u> CTATTC	6683
	GAATAGTTCAAGCCATG	6684
20 Increased stearate stearoyl-ACP desaturase <i>Olea europaea</i> Glu37Term GAG-TAG	GATGCTCGTATCAGATCTCACAGGGTTTTTCATGGCTTCAACTATTC ATTCTCCTTCTATGTAGGTCGGAAAAGTTAAAAAGCCTTTCACGCC TCCACGAGAGGTACATGTTCAAGTAACCC	6685
	GGGTACTTGAACATGTACCTCTCGTGGAGGCGTGAAAGGCTTTT AACTTTTCCGACCTACATAGAAGGAGAATGAATAGTTGAAGCCATG AAAACCCTGTGAGATCTGATACGAGCATC	6686
	CTTCTATGTAGGTCGGA	6687
	TCCGACCTACATAGAAG	6688

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Increased stearate stearoyl-ACP desaturase <i>Olea europaea</i> Gly39Term GGA-TGA	CGTATCAGATCTCACAGGGTTTTTCATGGCTTCAACTATTTCCTC CTTCTATGGAGGTCTGAAAAGTTAAAAAGCCTTTCACGCCTCCACG AGAGGTACATGTTCAAGTAACCCATTCT	6689
	AGGAATGGGTTACTTGAACATGTACCTCTCGTGGAGGCGTGAAAG GCTTTTTAACTTTTCAGACCTCCATAGAAGGAGAATGAATAGTTGA AGCCATGAAAACCTGTGAGATCTGATACG	6690
	TGGAGGTCTGAAAAGTT	6691
	AACTTTTCAGACCTCCA	6692
10 Increased stearate stearoyl-ACP desaturase <i>Persea americana</i> Lys4Term AAA-TAA	TTCTCGTTTTTGTCTGCCCTCTGCTCTCTCTCTATCAGGCACG GAGAAATGGCACTGTAAGTCACTCAGTCATGTTTCAATCTCAGAA GCTTCCATTTCTTGCCCTCTATCCGCCTT	6693
	AAGCGGATAGGAGGCAAGAAATGGAAGCTTCTGAGATTGAAACA TGAAGTGGAGTGAAGTACAGTGCCTTTCTCCGTGCCTGATAGAGA GAGAGAGCAGAGGGGACGACAAAAACGAGAA	6694
	TGGCACTGTAAGTCACT	6695
	ACTGAGTTACAGTGCCA	6696
15 Increased stearate stearoyl-ACP desaturase <i>Persea americana</i> Gln11Term CAA-TAA	CTGCTCTCTCTCTATCAGGCACGGAGAAATGGCACTGAAACTC AGTCCAGTCATGTTTTAATCTCAGAAGCTTCCATTTCTTGCCCTCCTA TCCGCCTTCCAATCTCAGATCTCCGAGGG	6697
	CCCTCGGAGATCTGAGATTGGAAGGCGGATAGGAGGCAAGAAAT GGAAGCTTCTGAGATTAAAACATGACTGGACTGAGTTTCAGTGCCA TTTCTCCGTGCCTGATAGAGAGAGAGAGCAG	6698
	TCATGTTTTAATCTCAG	6699
	CTGAGATTAAAACATGA	6700
20 Increased stearate stearoyl-ACP desaturase <i>Persea americana</i> Gln13Term CAG-TAG	TCTCTCTCTATCAGGCACGGAGAAATGGCACTGAAACTCAGTCCA GTCATGTTTCAATCTTGAAGCTTCCATTTCTTGCCCTCTATCCGC CTTCCAATCTCAGATCTCCGAGGGTTTTCA	6701
	TGAAAACCTCGGAGATCTGAGATTGGAAGGCGGATAGGAGGCAA GAAATGGAAGCTTCTAAGATTGAAACATGACTGGACTGAGTTTCAG TGCCATTTCTCCGTGCCTGATAGAGAGAGA	6702
	TTCAATCTTGAAGCTT	6703
	AAGCTTCTAAGATTGAA	6704
25 Increased stearate stearoyl-ACP desaturase <i>Persea americana</i> Lys14Term AAG-TAG	CTCTCTATCAGGCACGGAGAAATGGCACTGAAACTCAGTCCAGTC ATGTTTCAATCTCAGTAGCTTCCATTTCTTGCCCTCTATCCGCCTTC CAATCTCAGATCTCCGAGGGTTTTCATGG	6705
	CCATGAAAACCTCGGAGATCTGAGATTGGAAGGCGGATAGGAGG CAAGAAATGGAAGCTACTGAGATTGAAACATGACTGGACTGAGTTT CAGTGCCATTTCTCCGTGCCTGATAGAGAG	6706

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
5	AATCTCAGTAGCTTCCA	6707
	TGGAAGCTACTGAGATT	6708
	CCCCGAGATCTCGCTGCCGCTGCTCATGGCGTTCGCGGCGTCCC ACACCGCATCGCCGTAGTCTCTGCGGCGGCGTGGCGCAGAGGAG GAGCAATGGGATGTCGAAGATGGTGGCCATGGCC	6709
	GGCCATGGCCACCATTCTCGACATCCCATTGCTCCTCCTCTGCGC CACGCCGCCGAGGACTACGGCGATGCGGTGTGGGACGCCGCG AACGCCATGAGCAGCGGCAGCGAGATCTCGGGG	6710
	TCGCCGTAGTCCTGCGG	6711
10	CCGCAGGACTACGGCGA	6712
	CTGCTCATGGCGTTCGCGGCGTCCCACACCGCATCGCCGTACTC CTGCGGCGGCGTGGCGTAGAGGAGGAGCAATGGGATGTCGAAGA TGGTGGCCATGGCCTCCACCATCAACAGGGTCA	6713
	TGACCCTGTTGATGGTGGAGGCCATGGCCACCATTCTCGACATCC CATTGCTCCTCCTCTACGCCACGCCGCGCAGGAGTACGGCGAT GCGGTGTGGGACGCCGAACGCCATGAGCAG	6714
	GCGTGGCGTAGAGGAGG	6715
	CCTCCTCTACGCCACGC	6716
15	CCCACACCGCATCGCCGTACTCCTGCGGCGGCGTGGCGCAGAG GAGGAGCAATGGGATGTAGAAGATGGTGGCCATGGCCTCCACCA TCAACAGGGTCAAGACTGCTAAGAAGCCCTACAC	6717
	GTGTAGGGCTTCTTAGCAGTCTTGACCCTGTTGATGGTGGAGGCC ATGGCCACCATTCTTACATCCCATTGCTCCTCCTCTGCGCCACG CCGCCGAGGAGTACGGCGATGCGGTGTGGG	6718
	TGGGATGTAGAAGATGG	6719
	CCATCTTCTACATCCCA	6720
20	CACACCGCATCGCCGTACTCCTGCGGCGGCGTGGCGCAGAGGAG GAGCAATGGGATGTCGTAGATGGTGGCCATGGCCTCCACCATCAA CAGGGTCAAGACTGCTAAGAAGCCCTACACTC	6721
	GAGTGTAGGGCTTCTTAGCAGTCTTGACCCTGTTGATGGTGGAGG CCATGGCCACCATTCTACGACATCCCATTGCTCCTCCTCTGCGCCA CGCCGCCGAGGAGTACGGCGATGCGGTGTG	6722
	GGATGTCGTAGATGGTG	6723
	CACCATCTACGACATCC	6724

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO:
5 Increased stearate stearoyl-ACP desaturase <i>Simmondsia chinensis</i> Leu3Term TTG-TAG	TTCTCTCTCTAGGTTGAGCGGTTACCAACAGAAGCACTTAGGAGA GAGAAGCAATGGCGTGAAGCTTCACCACACGGCCTTCAATCCTT CCATGGCGGTTACCTCTTCGGGACTTCCTCG	6725
	CGAGGAAGTCCCGAAGAGGTAACCGCCATGGAAGGATTGAAGGC CGTGTGGTGAAGCTTCTACGCCATTGCTTCTCTCTCCTAAGTGCTT CTGTTGTAACCGCTCAACCTAGAGAGAGAA	6726
	AATGGCGTGAAGCTTC	6727
	GAAGCTTCTACGCCATT	6728
10 Increased stearate stearoyl-ACP desaturase <i>Simmondsia chinensis</i> Lys4Term AAG-TAG	CTCTCTCTAGGTTGAGCGGTTACCAACAGAAGCACTTAGGAGAGA GAAGCAATGGCGTTGTAGCTTCACCACACGGCCTTCAATCCTTCC ATGGCGGTTACCTCTTCGGGACTTCCTCGAT	6729
	ATCGAGGAAGTCCCGAAGAGGTAACCGCCATGGAAGGATTGAAG GCCGTGTGGTGAAGCTACAACGCCATTGCTTCTCTCTCCTAAGTG CTTCTGTTGGTAACCGCTCAACCTAGAGAGAG	6730
	TGGCGTTGTAGCTTCAC	6731
	GTGAAGCTACAACGCCA	6732
15 Increased stearate stearoyl-ACP desaturase <i>Simmondsia chinensis</i> Ser19Term TCG-TAG	AAGCAATGGCGTTGAAGCTTCACCACACGGCCTTCAATCCTTCCAT GGCGGTTACCTCTTAGGGACTTCCTCGATCGTATCACCTCAGATC TCACCGCGTTTTATGGCTTCTTCTACAAT	6733
	ATTGTAGAAGAAGCCATGAAAACGCGGTGAGATCTGAGGTGATAC GATCGAGGAAGTCCCTAAGAGGTAACCGCCATGGAAGGATTGAAG GCCGTGTGGTGAAGCTTCAACGCCATTGCTT	6734
	TACCTCTTAGGGACTTC	6735
	GAAGTCCCTAAGAGGTA	6736
20 Increased stearate stearoyl-ACP desaturase <i>Simmondsia chinensis</i> Gly20Term GGA-TGA	GCAATGGCGTTGAAGCTTCACCACACGGCCTTCAATCCTTCCATG GCGGTTACCTCTTCGTGACTTCCTCGATCGTATCACCTCAGATCTC ACCGCGTTTTATGGCTTCTTCTACAATTG	6737
	CAATTGTAGAAGAAGCCATGAAAACGCGGTGAGATCTGAGGTGAT ACGATCGAGGAAGTCAAGAGAGGTAACCGCCATGGAAGGATTGA AGGCCGTGTGGTGAAGCTTCAACGCCATTGC	6738
	CCTCTTCGTGACTTCCT	6739
	AGGAAGTCAAGAGAGG	6740
25 Increased stearate stearoyl-ACP desaturase <i>Spinacia oleracea</i> Ser21Term TCA-TGA	TGGCTCTGAATCTCAACCCCGTTTCCACACCATTTAGTGTCTGTCG ATTGCCGTCTTTCTGACCTCGTCAAACGCCTTCTCGCAGATCTCCC AAATTCTTCATGGCTTCCACTCTCAGCAG	6741
	CTGCTGAGAGTGGAAGCCATGAAGAATTTGGGAGATCTGCGAGAA GGCGTTTGACGAGGTGAGAAAGACGGCAATCGACGACACTGAAAT GGTGTGGAACGGGGTTGAGATTGAGAGCCA	6742

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GTCTTTCTGACCTCGTC	6743
	GACGAGGTGAGAAAGAC	6744
5 Increased stearate stearoyl-ACP desaturase <i>Spinacia oleracea</i> Gln24Term CAA-TAA	AATCTCAACCCCGTTTCCACACCATTTCAAGTGTCTCGTCGATTGCCGT CTTTCTCACCTCGTTAAACGCCTTCTCGCAGATCTCCCAAATTCTT CATGGCTTCCACTCTCAGCAGCTCTTCTC	6745
	GAGAAGAGCTGCTGAGAGTGGAAGCCATGAAGAATTTGGGAGATC TGCGAGAAGGCGTTTAAACGAGGTGAGAAAGACGGCAATCGACGA CACTGAAATGGTGTGGAACGGGGTTGAGATT	6746
	CACCTCGTTAAACGCCT	6747
	AGGCGTTTAAACGAGGTG	6748
10 Increased stearate stearoyl-ACP desaturase <i>Spinacia oleracea</i> Arg29Term AGA-TGA	TCCACACCATTTCAAGTGTCTCGTCGATTGCCGTCTTTCTCACCTCGTC AAACGCCTTCTCGCTGATCTCCCAAATTCTTCATGGCTTCCACTCT CAGCAGCTCTTCTCCTAAGGAAGCGGAAA	6749
	TTTCGCTTCCCTTAGGAGAAGAGCTGCTGAGAGTGGAAGCCATGA AGAATTTGGGAGATCAGCGAGAAGGCGTTTGACGAGGTGAGAAAG ACGGCAATCGACGACACTGAAATGGTGTGGA	6750
	CTTCTCGCTGATCTCCC	6751
	GGGAGATCAGCGAGAAG	6752
15 Increased stearate stearoyl-ACP desaturase <i>Spinacia oleracea</i> Lys32Term AAA-TAA	TTTCAGTGTCTCGTCGATTGCCGTCTTTCTCACCTCGTCAAACGCCTT CTCGCAGATCTCCCTAATTCTTCATGGCTTCCACTCTCAGCAGCTC TTCTCCTAAGGAAGCGGAAAGCCTGAAGA	6753
	TCTTCAGGCTTTCCGCTTCCCTTAGGAGAAGAGCTGCTGAGAGTGG AAGCCATGAAGAATTAGGGAGATCTGCGAGAAGGCGTTTGACGAG GTGAGAAAGACGGCAATCGACGACACTGAAA	6754
	GATCTCCCTAATTCTTC	6755
	GAAGAATTAGGGAGATC	6756
20 Increased stearate stearoyl-ACP desaturase <i>Solanum tuberosum</i> Leu10Term TTA-TGA	AAATAGTCGAGGTGAAAAACAGAGCATCAACAATGGCACTGAATAT CAATGGGGTGTCTGTGAAAATCTCACAAAATGTTACCATTTCTTGT TCTTCAGCCAGATCTGAGCGAGTTTTTCAT	6757
	ATGAAAACCTCGCTCAGATCTGGCTGAAGAACAAGGAAATGGTAACA TTTTGTGAGATTTTACGACACCCCATTTGATATTCAGTGCCATTGTT GATGCTCTGTTTTTACCTCGACTATTT	6758
	GGTGTCTGTGAAAATCTC	6759
	GAGATTTTACGACACC	6760

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Increased stearate stearoyl-ACP desaturase <i>Solanum tuberosum</i> Lys11Term AAA-TAA	ATAGTCGAGGTGAAAAACAGAGCATCAACAATGGCACTGAATATCA ATGGGGTGTCTGTTATAATCTCACAAATGTTACCATTTCTTCTTCT TCAGCCAGATCTGAGCGAGTTTTTCATGG	6761
	CCATGAAAACCTCGCTCAGATCTGGCTGAAGAACAAGGAAATGGTA ACATTTTGTGAGATTATAACGACACCCCATTGATATTCAGTGCCATT GTTGATGCTCTGTTTTTCACCTCGACTAT	6762
	TGTCGTTATAATCTCAC	6763
	GTGAGATTATAACGACA	6764
10 Increased stearate stearoyl-ACP desaturase <i>Solanum tuberosum</i> Lys14Term AAA-TAA	GTGAAAACAGAGCATCAACAATGGCACTGAATATCAATGGGGTGT CGTTAAATCTCACIAAATGTTACCATTTCTTCTTCTCAGCCAGA TCTGAGCGAGTTTTTCATGGCTTCAACCA	6765
	TGGTTGAAGCCATGAAAACCTCGCTCAGATCTGGCTGAAGAACAAG GAAATGGTAACATTTAGTGAGATTTTAACGACACCCCATTGATATTC AGTGCCATTGTTGATGCTCTGTTTTTCAC	6766
	AATCTCACIAAATGTTA	6767
	TAACATTTAGTGAGATT	6768
15 Increased stearate stearoyl-ACP desaturase <i>Solanum tuberosum</i> Leu16Term TTA-TGA	ACAGAGCATCAACAATGGCACTGAATATCAATGGGGTGTCTGTTAAA ATCTCACAAATGTGACCATTTCCTTGTTCTTCAGCCAGATCTGAG CGAGTTTTTCATGGCTTCAACCATTTCATCG	6769
	CGATGAATGGTTGAAGCCATGAAAACCTCGCTCAGATCTGGCTGAA GAACAAGGAAATGGTCACATTTTGTGAGATTTTAACGACACCCCAT TGATATTCAGTGCCATTGTTGATGCTCTGT	6770
	CAAAATGTGACCATTTC	6771
	GAAATGGTCACATTTTG	6772
20 Increased stearate stearoyl-ACP desaturase <i>Arachis hypogaea</i> Ser21Term TCA-TGA	TGGCTCTGAGGCTGAACCCTAACCCCTTACAGAAGCTCTTTCTCTC TCCTTCTTCATCATGATCTTCTTCTTCTTCATCGTTCTCGCTTCCTC AAATGGCTAGCCTCAGATCTCCAAGGT	6773
	AACCTTGAGATCTGAGGCTAGCCATTTGAGGAAGCGAGAACGAT GAAGAAGAAGAAGATCATGATGAAGAAGGAGAGAGAAAGAGCTTC TGTGAAGGGTTAGGGTTCAGCCTCAGAGCCA	6774
	TTCATCATGATCTTCTT	6775
	AAGAAGATCATGATGAA	6776
25 Increased stearate stearoyl-ACP desaturase <i>Arachis hypogaea</i> Ser26Term TCA-TGA	ACCCTAACCCCTTACAGAAGCTCTTTCTCTCTCCTTCTTCATCATCA TCTTCTTCTTCTTGATCGTTCTCGCTTCTCAAATGGCTAGCCTCA GATCTCCAAGGTTCCGCATGGCCTCCAC	6777
	GTGGAGGCCATGCGGAACCTTGGAGATCTGAGGCTAGCCATTTGA GGAAGCGAGAACGATCAAGAAGAAGAAGATGATGATGAAGAAGGA GAGAGAAAGAGCTTCTGTGAAGGGTTAGGGT	6778

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	TTCTTCTTGATCGTTCT	6779
	AGAACGATCAAGAAGAA	6780
	CTAACCCCTTCACAGAAGCTCTTTCTCTCTCCTTCTTCATCATCATCT TCTTCTTCTTCATAGTTCTCGCTTCCTCAAATGGCTAGCCTCAGAT CTCCAAGGTTCCGCATGGCCTCCACCCT	6781
	AGGGTGGAGGCCATGCGGAACCTTGAGATCTGAGGCTAGCCAT TTGAGGAAGCGAGAAGCTATGAAGAAGAAGAAGATGATGATGAAGA AGGAGAGAGAAAGAGCTTCTGTGAAGGGTTAG	6782
	TTCTTCATAGTTCTCGC	6783
10	GCGAGAAGCTATGAAGAA	6784
	CTTCACAGAAGCTCTTTCTCTCTCCTTCTTCATCATCATCTTCTTCT TCTTCATCGTTCTAGCTTCCTCAAATGGCTAGCCTCAGATCTCCAA GGTCCGCATGGCCTCCACCCTCCGCAC	6785
	GTGCGGAGGGTGGAGGCCATGCGGAACCTTGAGATCTGAGGCT AGCCATTTGAGGAAGCTAGAACGATGAAGAAGAAGAAGATGATGA TGAAGAAGGAGAGAGAAAGAGCTTCTGTGAAG	6786
	ATCGTTCTAGCTTCCTC	6787
	GAGGAAGCTAGAACGAT	6788
15	AAAGTTAAAAGCCGTCCAAAACCCAAACCAGGAAAGGCAAACGAA AAGAAAAATGGCTTAGAATTTAATGCCATCGCCTCGAAATCTCA GAAGCTCCCTTGCTTTGCTCTTCCACCAA	6789
	TTTGGTGGAAGAGCAAAGCAAGGGAGCTTCTGAGATTTGAGGGCG ATGGCATTAAAATTCTAAGCCATTTTTCTTTTCGTTTGCCTTTCCT GGTTTGGGTTTTGGACGGCTTTAACTTT	6790
	AATGGCTTAGAATTTA	6791
	TAAAATTCTAAGCCATT	6792
20	CCCAAACCAGGAAAGGCAAACGAAAAGAAAAAATGGCTTTGAATTT TAATGCCATCGCCTAGAAATCTCAGAAGCTCCCTTGCTTTGCTCTT CCACCAAAGGCCACCCTTAGATCTCCCAA	6793
	TTGGGAGATCTAAGGGTGGCCTTTGGTGAAGAGCAAAGCAAGG GAGCTTCTGAGATTTCTAGGCGATGGCATTAAAATCAAAGCCATT TTTTCTTTTCGTTTGCCTTTCCTGGTTTGGG	6794
	CATCGCCTAGAAATCTC	6795
	GAGATTTCTAGGCGATG	6796

5

10

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
Increased stearate stearoyl-ACP desaturase <i>Gossypium hirsutum</i> Lys11Term AAA-TAA	CAAACCAGGAAAGGCAAACGAAAAGAAAAATGGCTTTGAATTTTA ATGCCATCGCCTCGTAATCTCAGAAGCTCCCTTGCTTTGCTCTTCC ACCAAAGGCCACCCTTAGATCTCCCAAGT	6797
	ACTTGGGAGATCTAAGGGTGGCCTTTGGTGGGAAGAGCAAAGCAAG GGAGCTTCTGAGATTACGAGGCGATGGCATTAAAATTCAAAGCCA TTTTTCTTTTCGTTTGCCTTTCCTGGTTTG	6798
	TCGCCTCGTAATCTCAG	6799
	CTGAGATTACGAGGCGA	6800
Increased stearate stearoyl-ACP desaturase <i>Gossypium hirsutum</i> Gln13Term CAG-TAG	AGGAAAGGCAAACGAAAAGAAAAATGGCTTTGAATTTTAATGCCA TCGCCTCGAAATCTTAGAAGCTCCCTTGCTTTGCTCTTCCACCAAA GGCCACCCTTAGATCTCCCAAGTTTTCCA	6801
	TGGAAACTTGGGAGATCTAAGGGTGGCCTTTGGTGGGAAGAGCAA AGCAAGGGAGCTTCTAAGATTTGAGGCGATGGCATTAAAATTCAA AGCCATTTTTCTTTTCGTTTGCCTTTCCT	6802
	CGAAATCTTAGAAGCTC	6803
	GAGCTTCTAAGATTTG	6804

Table 24
Oligonucleotides to produce plants with reduced linolenic acid

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Arabidopsis thaliana</i> Ser4Term TCG-TAG	AATAGAACGACAGAGACTTTTCTCTTTCTTCTTGGGAAGAGGC TCCAATGGCGAGCTAGGTTTTATCAGAATGTGGTTTAGACCTCTC CCCAGATTCTACCCTAAACACACAACCTC	6805
	GAGGTTGTGTGTTAGGGTAGAATCTGGGGAGAGGTCTAAACCA CATTCTGATAAAACCTAGCTCGCCATTGGAGCCTCTTCCCAAGAAG AAAAGAGGAAAAAGTCTCTGTCTGTTCTATT	6806
	GGCGAGCTTGGTTTTAT	6807
	ATAAAACCAAGCTCGCC	6808
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Arabidopsis thaliana</i> Leu6Term TTA-TGA	ACGACAGAGACTTTTCTCTTTCTTCTTGGGAAGAGGCTCCAAT GGCGAGCTCGGTTTGATCAGAATGTGGTTTAGACCTCTCCCCAG ATTCTACCCTAAACACACAACCTCTTTTGC	6809
	GCAAAAGAGGTTGTGTGTTAGGGTAGAATCTGGGGAGAGGTCTA AAACCACATTCTGATCAAACCGAGCTCGCCATTGGAGCCTCTTCC CAAGAAGAAAAGAGGAAAAAGTCTCTGTCTGT	6810
	CTCGGTTTGATCAGAAT	6811
	ATTCTGATCAAACCGAG	6812
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Arabidopsis thaliana</i> Ser7Term TCA-TGA	ACAGAGACTTTTCTCTTTCTTCTTGGGAAGAGGCTCCAATGGC GAGCTCGGTTTTATGAGAATGTGGTTTAGACCTCTCCCCAGATTCT TACCCTAAACACACAACCTCTTTTGCCTC	6813
	GAGGCAAAAGAGGTTGTGTGTTAGGGTAGAATCTGGGGAGAGGT CTAAACCACATTCTCATAAAACCGAGCTCGCCATTGGAGCCTCTT CCCAAGAAGAAAAGAGGAAAAAGTCTCTGT	6814
	GGTTTTATGAGAATGTG	6815
	CACATTCTCATAAAACC	6816
25 Reduced linolenic acid omega-3 fatty acid desaturase <i>Arabidopsis thaliana</i> Glu8Term GAA-TAA	AGAGACTTTTCTCTTTCTTCTTGGGAAGAGGCTCCAATGGCGA GCTCGGTTTTATCATATGTGGTTTAGACCTCTCCCCAGATTCTA CCCTAAACACACAACCTCTTTTGCCTCTA	6817
	TAGAGGCAAAAGAGGTTGTGTGTTAGGGTAGAATCTGGGGAGAG GTCTAAACCACATTATGATAAAACCGAGCTCGCCATTGGAGCCTC TTCCAAGAAGAAAAGAGGAAAAAGTCTCT	6818
	TTTTATCATATGTGGT	6819
	ACCACATTATGATAAAA	6820

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica juncea</i> Leu4Term TTG-TAG	TCATCATCTTCTTCTTCTGGGGAGAGAGAGAGAGAGCAAAAGAGCTCT AGCAATGGCGAACTAGGTCTTATCCGAATGTGGCATAAGACCTCT CCCCAGAATCTACACCACACCCAGATCCAC	6821
	GTGGATCTGGGTGTGGTGTAGATTCTGGGGAGAGGTCTTATGCCA CATTCGGATAAGACCTAGTTCGCCATTGCTAGAGCTCTTTTGTCTCT CTCTCTCTCCCCAGAAGAAGAAGATGATGA	6822
	GGCGAACTAGGTCTTAT	6823
	ATAAGACCTAGTTCGCC	6824
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica juncea</i> Leu6Term TTA-TGA	TCTTCTTCTTCTGGGGAGAGAGAGAGAGAGCAAAAGAGCTCTAGCAA TGGCGAACTTGGTCTGATCCGAATGTGGCATAAGACCTCTCCCCA GAATCTACACCACACCCAGATCCACTTTCCT	6825
	AGGAAAGTGGATCTGGGTGTGGTGTAGATTCTGGGGAGAGGTCTT ATGCCACATTGGATCAGACCAAGTTCGCCATTGCTAGAGCTCTTT TGCTCTCTCTCTCTCCCCAGAAGAAGA	6826
	CTTGGTCTGATCCGAAT	6827
	ATTCGGATCAGACCAAG	6828
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica juncea</i> Glu8Term GAA-TAA	TTCTTCTGGGGAGAGAGAGAGAGAGCAAAAGAGCTCTAGCAATGGCG AACTTGGTCTTATCCTAATGTGGCATAAGACCTCTCCCCAGAATCT ACACCACACCCAGATCCACTTTCCTCTCCA	6829
	TGGAGAGGAAAAGTGGATCTGGGTGTGGTGTAGATTCTGGGGAGA GGTCTTATGCCACATTAGGATAAGACCAAGTTCGCCATTGCTAGAG CTCTTTTGCTCTCTCTCTCTCCCCAGAAGAA	6830
	TCTTATCCTAATGTGGC	6831
	GCCACATTAGGATAAGA	6832
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica juncea</i> Cys9Term TGT-TGA	CTGGGGAGAGAGAGAGAGAGCAAAAGAGCTCTAGCAATGGCGAACTT GGTCTTATCCGAATGAGGCATAAGACCTCTCCCCAGAATCTACAC CACACCCAGATCCACTTTCCTCTCCAACACC	6833
	GGTGTGGAGAGGAAAAGTGGATCTGGGTGTGGTGTAGATTCTGGG GAGAGGTCTTATGCCCTCATTTCGGATAAGACCAAGTTCGCCATTGCT AGAGCTCTTTTGCTCTCTCTCTCTCCCCAG	6834
	TCCGAATGAGGCATAAG	6835
	CTTATGCCCTCATTCCGA	6836
25 Reduced linolenic acid omega-3 fatty acid desaturase <i>Ricinus communis</i> Trp5Term TGG-TGA	ATAACAGAATTGCTGAATTCTTGCAATTTTAGCTTCTGGGTTTTCAA TGGCTGCTGGTTGAGTATTATCAGAATGTGGTTAAGGCCTCTCCC AAGAATCTACTCAGACCCAGAATTGGT	6837
	ACCAATTCTGGGTGCTGAGTAGATTCTTGGGAGAGGCCTTAAACC ACATTCTGATAATACTCAACCAGCAGCCATTGAAAACCCAGAAGCT AAAAATGCAAGAATTCAGCAATTCTGTTAT	6838

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	GCTGGTTGAGTATTATC	6839
	GATAATACTCAACCAGC	6840
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Ricinus communis</i> Leu7Term TTA-TGA	AGAATTGCTGAATTCTTGCAATTTTAGCTTCTGGGTTTTCAATGGCT GCTGGTTGGGTATGATCAGAATGTGGTTTAAGGCCTCTCCCAAGA ATCTACTCACGACCCAGAATTGGTTTTAC	6841
	GTAACCAATTCTGGGTCGTGAGTAGATTCTTGGGAGAGGCCTT AAACCACATTCTGATCATACCAACCAGCAGCCATTGAAAACCCAG AAGCTAAAAATGCAAGAATTCAGCAATTCT	6842
	TTGGGTATGATCAGAAT	6843
	ATTCTGATCATACCAA	6844
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Ricinus communis</i> Ser8Term TCA-TGA	ATTGCTGAATTCTTGCAATTTTAGCTTCTGGGTTTTCAATGGCTGCT GGTTGGGTATTATGAGAATGTGGTTTAAGGCCTCTCCCAAGAATCT ACTCACGACCCAGAATTGGTTTTACATC	6845
	GATGTAACCAATTCTGGGTCGTGAGTAGATTCTTGGGAGAGGC CTTAAACCACATTCTCATAATACCAACCAGCAGCCATTGAAAACC CAGAAGCTAAAAATGCAAGAATTCAGCAAT	6846
	GGTATTATGAGAATGTG	6847
	CACATTCTCATAATACC	6848
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Ricinus communis</i> Glu9Term GAA-TAA	TGCTGAATTCTTGCAATTTTAGCTTCTGGGTTTTCAATGGCTGCTG GTTGGGTATTATCATAATGTGGTTTAAGGCCTCTCCCAAGAATCTA CTCACGACCCAGAATTGGTTTTACATCGA	6849
	TCGATGTAACCAATTCTGGGTCGTGAGTAGATTCTTGGGAGAG GCCTTAAACCACATTATGATAATACCAACCAGCAGCCATTGAAAA CCCAGAAGCTAAAAATGCAAGAATTCAGCA	6850
	TATTATCATAATGTGGT	6851
	ACCACATTATGATAATA	6852
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Nicotiana tabacum</i> Arg22Term AGA-TGA	GCAAGTTGGGTTTTATCAGAATGTGGTCTTAGACCACTCCCAAGAA TCTACCCTAAGCCCTGAACTGGGGCAGCCACTTCTGCCTCCTCTC ACATTAAGTTGAGAATTCACGTACAGATC	6853
	GATCTGTACGTGAAATTCTCACTTAATGTGAGAGGAGGCAGAAGT GGCTGCCCCAGTTCAAGGGCTTAGGGTAGATTCTTGGGAGTGGTCT AAGACCACATTCTGATAAACCAACTTGC	6854
	CTAAGCCCTGAACTGGG	6855
	CCCAGTTCAGGGCTTAG	6856

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Nicotiana tabacum</i> Lys34Term AAG-TAG	CTCCCAAGAATCTACCCTAAGCCCAGAAGCTGGGGCAGCCACTTCT GCCTCCTCTCACATTAGTTGAGAATTTACGTACAGATCTGAGTG GTTCTGCAATTTCTTTGTCTAATACTAATA	6857
	TATTAGTATTAGACAAAGAAATTGCAGAACCACTCAGATCTGTACG TGAAATTCTCAACTAAATGTGAGAGGAGGCAGAAGTGGCTGCCCC AGTTCTGGGCTTAGGGTAGATTCTTGGGAG	6858
	CTCACATTAGTTGAGA	6859
	TCTCAACTAAATGTGAG	6860
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Nicotiana tabacum</i> Leu35Term TTG-TAG	CAAGAATCTACCCTAAGCCCAGAAGCTGGGGCAGCCACTTCTGCCT CCTCTCACATTAAGTAGAGAATTTACGTACAGATCTGAGTGGTTC TGCAATTTCTTTGTCTAATACTAATAAAGA	6861
	TCTTTATTAGTATTAGACAAAGAAATTGCAGAACCACTCAGATCTGT ACGTGAAATTCTCTACTTAATGTGAGAGGAGGCAGAAGTGGCTGC CCCAGTTCTGGGCTTAGGGTAGATTCTTG	6862
	CATTAAGTAGAGAATTT	6863
	AAATTCTCTACTTAATG	6864
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Nicotiana tabacum</i> Arg36Term AGA-TGA	AGAATCTACCCTAAGCCCAGAAGCTGGGGCAGCCACTTCTGCCTCC TCTCACATTAAGTTGTGAATTTACGTACAGATCTGAGTGGTCTG CAATTTCTTTGTCTAATACTAATAAAGAGA	6865
	TCTCTTTATTAGTATTAGACAAAGAAATTGCAGAACCACTCAGATCT GTACGTGAAATTCACAACTTAATGTGAGAGGAGGCAGAAGTGGCT GCCCCAGTTCTGGGCTTAGGGTAGATTCT	6866
	TTAAGTTGTGAATTTCA	6867
	TGAAATTCACAACTTAA	6868
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Sesamum indicum</i> Arg22Term AGA-TGA	GCGAGTTGGGTTTTATCAGAATGTGGTCTGAGGCCACTCCCGAGG GTCTATCCTAAGCCATGAAGTGGCCACCCTTTGTTGAATCCAATC CCACAAAGCTGAGATTTTCAAGAACAGATC	6869
	GATCTGTTCTTGAAAATCTCAGCTTTGTGGGATTGGAATTCAACAA AGGGTGGCCAGTTCAATGGCTTAGGATAGACCCTCGGGAGTGGCC TCAGACCACATTCTGATAAAACCCAACCTCGC	6870
	CTAAGCCATGAAGTGGC	6871
	GCCAGTTCAATGGCTTAG	6872
25 Reduced linolenic acid omega-3 fatty acid desaturase <i>Sesamum indicum</i> Leu27Term TTG-TAG	CAGAATGTGGTCTGAGGCCACTCCCGAGGGTCTATCCTAAGCCAA GAACTGGCCACCCTTAGTTGAATTTCCAATCCACAAAGCTGAGATT TTCAAGAACAGATCTTGAAATGGTTCTTC	6873
	GAAGAACCATTTCCAAGATCTGTTCTTGAAAATCTCAGCTTTGTGG GATTGGAATTCAACTAAGGGTGGCCAGTTCTTGGCTTAGGATAGA CCCTCGGGAGTGGCCTCAGACCACATTCTG	6874

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CCACCCTT <u>A</u> GTTGAATT	6875
	AATTCAAC <u>T</u> AAGGGTGG	6876
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Sesamum indicum</i> Leu28Term TTG-TAG	AATGTGGTCTGAGGCCACTCCCGAGGGTCTATCCTAAGCCAAGAA CTGGCCACCCTTTGT <u>A</u> GAATTCCAATCCCACAAAGCTGAGATTTTC AAGAACAGATCTTGGAATGGTTCTTCATT	6877
	AATGAAGAACCATTTCCAAGATCTGTTCTTGAAAATCTCAGCTTTGT GGGATTGGAATTCTACAAAGGGTGGCCAGTTCTTGGCTTAGGATA GACCCTCGGGAGTGGCCTCAGACCACATT	6878
	CCCTTTGT <u>A</u> GAATTCCA	6879
	TGGAATTCTACAAAGGG	6880
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Sesamum indicum</i> Lys34Term AAG-TAG	CTCCCGAGGGTCTATCCTAAGCCAAGAACTGGCCACCCTTTGTTG AATTCCAATCCCACAT <u>A</u> GCTGAGATTTTCAAGAACAGATCTTGAA ATGGTTCTTCATTCTGTTTGTCGAGTGGA	6881
	TCCCACTCGACAAACAGAATGAAGAACCATTTCCAAGATCTGTTCT TGAAAATCTCAGCT <u>A</u> TGTGGGATTGGAATTCAACAAAGGGTGGCC AGTTCTTGGCTTAGGATAGACCCTCGGGAG	6882
	ATCCACAT <u>A</u> GCTGAGA	6883
	TCTCAGCT <u>A</u> TGTGGGAT	6884
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica napus</i> Tyr3Term TAC-TAG	CATCAGAGCGGCGATACCTAAGCATTGCTGGGTAAAGAATCCATG GAAGTCTATGAGTTA <u>G</u> GTCTGAGAGCTAGCCATCGTGTTCCG ACTAGCTGCTGGAGCTGCTTACCTCAACAAT	6885
	ATTGTTGAGGTAAGCAGCTCCAGCAGCTAGTGCGAACACGATGGC TAGCTCTCTGACGAC <u>C</u> TAACCTCATAGACTTCCATGGATTCTTAACC CAGCAATGCTTAGGTATCGCCGCTCTGATG	6886
	ATGAGTTA <u>G</u> GTCTGAG	6887
	CTGACGAC <u>C</u> TAACCTCAT	6888
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica napus</i> Arg6Term AGA-TGA	GCGGCGATACCTAAGCATTGCTGGGTAAAGAATCCATGGAAGTCT ATGAGTTACGTCGTC <u>T</u> GAGAGCTAGCCATCGTGTTGCGACTAGCT GCTGGAGCTGCTTACCTCAACAATTGGCTTG	6889
	CAAGCCAATTGTTGAGGTAAGCAGCTCCAGCAGCTAGTGCGAACA CGATGGCTAGCTCTC <u>A</u> GACGACGTAACCTCATAGACTTCCATGGAT TCTTAACCCAGCAATGCTTAGGTATCGCCGC	6890
	ACGTCGTC <u>T</u> GAGAGCTA	6891
	TAGCTCTC <u>A</u> GACGACGT	6892

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica napus</i> Glu7Term GAG-TAG	GCGATACCTAAGCATTGCTGGGTAAAGAATCCATGGAAGTCTATGA GTTACGTCGTCAGATAGCTAGCCATCGTGTTGCGACTAGCTGCTG GAGCTGCTTACCTCAACAATTGGCTTGTTT	6893
	AAACAAGCCAATTGTTGAGGTAAGCAGCTCCAGCAGCTAGTGCGA ACACGATGGCTAGCTATCTGACGACGTAACCTCATAGACTTCCATG GATTCTTAACCCAGCAATGCTTAGGTATCGC	6894
	TCGTCAGATAGCTAGCC	6895
	GGCTAGCTATCTGACGA	6896
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Brassica napus</i> Gly17Term GGA-TGA	CCATGGAAGTCTATGAGTTACGTCGTCAGAGAGCTAGCCATCGTG TTCGCGACTAGCTGCTTGAGCTGCTTACCTCAACAATTGGCTTGTTT GGCCTCTCTATTGGATTGCTCAAGGAACCA	6897
	TGGTTCCTTGAGCAATCCAATAGAGAGGCCAAACAAGCCAATTGTT GAGGTAAGCAGCTCAAGCAGCTAGTGCGAACACGATGGCTAGCT CTCTGACGACGTAACCTCATAGACTTCCATGG	6898
	TAGCTGCTTGAGCTGCT	6899
	AGCAGCTCAAGCAGCTA	6900
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Solanum tuberosum</i> Arg22Term AGA-TGA	GCAAGTTGGGTCTATCAGAATGTGGTCTTAGACCACTACCAAGAA TATACCCAAAGCCCIGAATAGGGTCTTCTTCCGTTTGCGCCACCAA TTTAAATCTGAGAAGAATTTACCTTCAC	6901
	GTGAAGGTGAAATTTCTCTCAGATTTAAATTGGTGGCGCAAACGGA AGAAGACCCTATTCAAGGGCTTTGGGTATATTCTTGGTAGTGGTCTA AGACCACATTCTGATAGAACCCAACCTGC	6902
	CAAAGCCCIGAATAGGG	6903
	CCCTATTCAGGGCTTTG	6904
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Solanum tuberosum</i> Cys29Term TGC-TGA	TGGTCTTAGACCACTACCAAGAATATACCCAAAGCCCAGAATAGG GTCTTCTTCCGTTTGAGCCACCAATTTAAATCTGAGAAGAATTTCA CCTTCACCTATACGAACAGATCGGAATTGT	6905
	ACAATTCGATCTGTTCTGATAGGTGAAGGTGAAATTCTTCTCAGA TTTAAATTGGTGGCTCAAACGGAAGAAGACCCTATTCTGGGCTTTG GGTATATTCTTGGTAGTGGTCTAAGACCA	6906
	TCCGTTTGAGCCACCAA	6907
	TTGGTGGCTCAAACGGA	6908
25 Reduced linolenic acid omega-3 fatty acid desaturase <i>Solanum tuberosum</i> Leu33Term TTA-TGA	CACTACCAAGAATATACCCAAAGCCCAGAATAGGGTCTTCTTCCGT TTGCGCCACCAATTGAAATCTGAGAAGAATTTACCTTCACCTATA CGAACAGATCGGAATTGTTGGGCATTGAG	6909
	CTCAATGCCCAACAATTCCGATCTGTTCTGATAGGTGAAGGTGAAA TTCTTCTCAGATTTCAATTGGTGGCGCAAACGGAAGAAGACCCTAT TCTGGGCTTTGGGTATATTCTTGGTAGTG	6910

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	CACCAATTGAAATCTGA	6911
	TCAGATTTCAATTGGTG	6912
	AGAATATACCCAAAGCCCAGAATAGGGTCTTCTTCCGTTTGCGCCA CCAATTTAAATCTGTGAAGAATTTACCTTCACCTATACGAACAGAT CGGAATTGTTGGGCATTGAGGGTAAGTG	6913
	CACTTACCCTCAATGCCCAACAATTCCGATCTGTTCGTATAGGTGA AGGTGAAATCTTCAACAGATTTAAATTGGTGGCGCAAACGGAAGAA GACCCTATTCTGGGCTTTGGGTATATTCT	6914
	TAAATCTGTGAAGAATT	6915
10	AATTCTTCACAGATTTA	6916
	CTCTTTATTATCCTCCTCTTCTTTGTTTTTTGAGTTCTGAGTCACC TATGGCAAGTTGAGTGATTTCAGAATGTGGGCTAAGGCCACTTCC AAGAATCTATGCCAGGCCCAGAAGTGGA	6917
	TCCACTTCTGGGCCTGGCATAGATTCTTGGAAGTGGCCTTAGCCC ACATTCTGAAATCACTCAACTTGCCATAGGTGACTCAGAACTCAA AAAAACAAAGAAGAGGAGGATAATAAAGAG	6918
	GCAAGTTGAGTGATTTC	6919
	GAAATCACTCAACTTGC	6920
15	TATCCTCCTCTTCTTTGTTTTTTGAGTTCTGAGTCACCTATGGCA AGTTGGGTGATTTGAGAATGTGGGCTAAGGCCACTTCCAAGAATC TATGCCAGGCCCAGAAGTGAGCTTCATG	6921
	CATGAAGCTCCACTTCTGGGCCTGGCATAGATTCTTGGAAGTGGC CTTAGCCCACATTCTCAAAACACCCAACTTGCCATAGGTGACTCAG AACTCAAAAAACAAAGAAGAGGAGGATA	6922
	GGTGATTTGAGAATGTG	6923
	CACATTCTCAAAATCACC	6924
20	TCCTCCTCTTCTTTGTTTTTTGAGTTCTGAGTCACCTATGGCAAG TTGGGTGATTTCAATATGTGGGCTAAGGCCACTTCCAAGAATCTAT GCCAGGCCCAGAAGTGAGCTTCATGTT	6925
	AACATGAAGCTCCACTTCTGGGCCTGGCATAGATTCTTGGAAGTG GCCTTAGCCCACATTATGAAATCACCCAACTTGCCATAGGTGACTC AGAACTCAAAAAACAAAGAAGAGGAGGA	6926
	TGATTTCAATATGTGGG	6927
	CCCACATTATGAAATCA	6928

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Petroselinum crispum</i> Cys9Term TGT-TGA	CTCTTCTTTGTTTTTTTGTAGTTCTGAGTCACCTATGGCAAGTTGGG TGATTTCAGAATGAGGGCTAAGGCCACTTCCAAGAATCTATGCCA GGCCCAGAAAGTGAGCTTCATGTTTCAAC	6929
	GTTGAAACATGAAGCTCCACTTCTGGGCCTGGCATAGATTCTTGGA AGTGGCCTTAGCCCTCATTCTGAAATCACCCAAGTGGCATAGGTG ACTCAGAACTCAAAAAAACAAGAAGAG	6930
	TCAGAATGAGGGCTAAG	6931
	CTTAGCCCCIATTCTGA	6932
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Vernicia fordii</i> Lys21Term AAA-TAA	ATGAAGCAGCAACAGTACAAAGACACCCCAATTCTAAATGGCGTTA ATGGTTTTCATGCTAAGAAGAAGAAGAAGAGGATTTGACTT AAGCAATCCTCCTCCATTCAATATTGGTC	6933
	GACCAATATTGAATGGAGGAGGATTGCTTAAGTCGAAATCCTCTTC TTCTTCTTCTTCTTAAGCATGAAAACCATTACGCCATTTAGAATTG GGGTGTCTTTGTAAGTGTGCTTCAT	6934
	TTCATGCTAAGAAGAA	6935
	TTCTTCTTAAGCATGAA	6936
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Vernicia fordii</i> Glu22Term GAA-TAA	AAGCAGCAACAGTACAAAGACACCCCAATTCTAAATGGCGTTAATG GTTTTTCATGCTAAATAAGAAGAAGAAGAGGATTTGACTTAAG CAATCCTCCTCCATTCAATATTGGTCAGA	6937
	TCTGACCAATATTGAATGGAGGAGGATTGCTTAAGTCGAAATCCTC TTCTTCTTCTTCTTATTAGCATGAAAACCATTACGCCATTTAGAA TTGGGGTGTCTTTGTAAGTGTGCTGCTT	6938
	ATGCTAAATAAGAAGAA	6939
	TTCTTCTTATTAGCAT	6940
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Vernicia fordii</i> Glu23Term GAA-TAA	CAGCAACAGTACAAAGACACCCCAATTCTAAATGGCGTTAATGGTT TTCATGCTAAAGAATAAGAAGAAGAAGAGGATTTGACTTAAGCAA TCCTCCTCCATTCAATATTGGTCAGATCC	6941
	GGATCTGACCAATATTGAATGGAGGAGGATTGCTTAAGTCGAAATC CTCTTCTTCTTCTTATTCTTTAGCATGAAAACCATTACGCCATTTA GAATTGGGGTGTCTTTGTAAGTGTGCTG	6942
	CTAAAGAATAAGAAGAA	6943
	TTCTTCTTATTCTTTAG	6944
25 Reduced linolenic acid omega-3 fatty acid desaturase <i>Vernicia fordii</i> Glu24Term GAA-TAA	CAGCAACAGTACAAAGACACCCCAATTCTAAATGGCGTTAATGGTT TTCATGCTAAAGAATAAGAAGAAGAAGAGGATTTGACTTAAGCAA TCCTCCTCCATTCAATATTGGTCAGATCC	6945
	GGATCTGACCAATATTGAATGGAGGAGGATTGCTTAAGTCGAAATC CTCTTCTTCTTCTTATTCTTTAGCATGAAAACCATTACGCCATTTA GAATTGGGGTGTCTTTGTAAGTGTGCTG	6946

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
	CTAAAGAATAAGAAGAA	6947
	TTCTTCTT <u>A</u> TTCTTTAG	6948
Reduced linolenic acid omega-3 fatty acid desaturase <i>Glycine max</i> Tyr21Term TAT-TAG	GGTCCAAGCACAGCCTCTACAACATGTTGGTAATGGTGCAGGGAA AGAAGATCAAGCTTAG <u>G</u> TTTGATCCAAGTGCTCCACCACCCTTCAAG ATTGCAAATATCAGAGCAGCAATTCCAAAA	6949
	TTTTGGAATTGCTGCTCTGATATTTGCAATCTTGAAGGGTGGTGGG GCACTTGGATCAA <u>C</u> TAAGCTTGATCTTCTTTCCCTGCACCATTAC CAACATGTTGTAGAGGCTGTGCTTGGACC	6950
	CAAGCTTAG <u>G</u> TTTGATCC	6951
	GGATCAAA <u>C</u> TAAGCTTG	6952
Reduced linolenic acid omega-3 fatty acid desaturase <i>Glycine max</i> Lys31Term AAG-TAG	GGTAATGGTGCAGGGAAAGAAGATCAAGCTTATTTTGATCCAAGTG CTCCACCACCCTTCTAGATTGCAAATATCAGAGCAGCAATTCCAAA ACATTGCTGGGAGAAGAACACATTGAGAT	6953
	ATCTCAATGTGTTCTTCTCCAGCAATGTTTTGGAATTGCTGCTCT GATATTTGCAATCTA <u>G</u> AAGGGTGGTGGAGCACTTGGATCAAATAA GCTTGATCTTCTTTCCCTGCACCATTACC	6954
	CACCCTTCTAGATTGCA	6955
	TGCAATCTA <u>G</u> AAGGGTG	6956
Reduced linolenic acid omega-3 fatty acid desaturase <i>Glycine max</i> Arg36Term AGA-TGA	AAAGAAGATCAAGCTTATTTTGATCCAAGTGCTCCACCACCCTTCA AGATTGCAAATATCT <u>G</u> AGCAGCAATTCCAAAACATTGCTGGGAGAA GAACACATTGAGATCTCTGAGTTATGTTT	6957
	GAACATAACTCAGAGATCTCAATGTGTTCTTCTCCAGCAATGTTTT GGAATTGCTGCTC <u>A</u> GATATTTGCAATCTTGAAGGGTGGTGGAGCA CTTGGATCAAATAAGCTTGATCTTCTTT	6958
	CAAATATCT <u>G</u> AGCAGCA	6959
	TGCTGCTC <u>A</u> GATATTTG	6960
Reduced linolenic acid omega-3 fatty acid desaturase <i>Glycine max</i> Leu41Term AAA-TAA	TATTTTGATCCAAGTGCTCCACCACCCTTCAAGATTGCAAATATCA GAGCAGCAATTCCAT <u>A</u> ACATTGCTGGGAGAAGAACACATTGAGATC TCTGAGTTATGTTCTGAGGGATGTGTTGG	6961
	CCAACACATCCCTCAGAACATAACTCAGAGATCTCAATGTGTTCTT CTCCAGCAATGTTA <u>T</u> GGAATTGCTGCTCTGATATTTGCAATCTTG AAGGGTGGTGGAGCACTTGGATCAAATA	6962
	CAATTCCAT <u>A</u> ACATTGC	6963
	GCAATGTT <u>A</u> TGGAATTG	6964

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Zea mays</i> Glu8Term GAG-TAG	CATCCACCCGCACCCGCACCCGCCCCGCTGACGGCGGCAATGGC CCGGCTCGTGCTCTCCTAGTGCTCGGGCCTCGCGCCCGTCCGCC GCCTGCGCGCCGGCCGGGGCGCCATTGCGGGCGC	6965
	GCGCCGCAATGGCGCCCCGGCCGGCGCGCAGGCGGCGGACGG GCGCGAGGCCCGAGCACTAGGAGAGCACGAGCCGGGCCATTGC CGCCGTGAGCGGGGGCGGGTGCGGGTGCGGGTGGATG	6966
	TGCTCTCCTAGTGCTCG	6967
	CGAGCACTAGGAGAGCA	6968
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Zea mays</i> Cys9Term TGC-TGA	ACCCGCACCCGCACCCGCCCCGCTGACGGCGGCAATGGCCCCG CTCGTGCTCTCCGAGTGATCGGGCCTCGCGCCCGTCCGCCGCCT GCGCGCCGGCCGGGGCGCCATTGCGGCGCGGTCA	6969
	TGACCGCGCCGCAATGGCGCCCCGGCCGGCGCGCAGGCGGCGG ACGGGCGCGAGGCCCGATCACTCGGAGAGCACGAGCCGGGCCA TTGCCGCCGTGAGCGGGGGCGGGTGCGGGTGCGGGT	6970
	TCCGAGTGATCGGGCCT	6971
	AGGCCCGATCACTCGGA	6972
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Zea mays</i> Ser10Term TCG-TAG	CCGCACCCGCACCCGCCCCGCTGACGGCGGCAATGGCCCCGCT CGTGCTCTCCGAGTGCTAGGGCCTCGCGCCCGTCCGCCGCCTGC GCGCCGGCCGGGGCGCCATTGCGGCGCGGTCA	6973
	GGTGACCGCGCCGCAATGGCGCCCCGGCCGGCGCGCAGGCGGC GGACGGGCGCGAGGCCCTAGCACTCGGAGAGCACGAGCCGGGC CATTGCCGCCGTGAGCGGGGGCGGGTGCGGGTGCGG	6974
	CGAGTGCTAGGGCCTCG	6975
	CGAGGCCCTAGCACTCG	6976
20 Reduced linolenic acid omega-3 fatty acid desaturase <i>Zea mays</i> Ser29Term TCA-TGA	GCTCGGGCCTCGCGCCCGTCCGCCGCCTGCGCGCCGGCCGGGG CGCCATTGCGGCGCGGTGACCCCCCGCGCTCTCCGCGGCGCCG CGCCGTCTCCCGCGTCCGCGTCCATCCACCGCGA	6977
	TCGCGGTGGATGGACGCGGACGCGGGACGACGGCGCGGCGCCG CGGAGAGCGCGGGGGGTACCGCGCCGCAATGGCGCCCCGGCC GGCGCGCAGGCGGCGGACGGGCGCGAGGCCCGAGC	6978
	GGCGCGGTGACCCCCCG	6979
	CGGGGGGTGACCGCGCC	6980
25 Reduced linolenic acid omega-3 fatty acid desaturase <i>Triticum aestivum</i> Glu8Term GAG-TAG	CCCCCTCCCCACGCACACGCACAGATCCATCCGCGGCCATGGC CCCCGCAATGAGGCCGTAGCAGGAGGCGAGCTGCAAGGCCACC GAGGACCACCGCTCCGAGTTCGACGCCGCCAAGC	6981
	GCTTGGCGGCGTGAAGTTCGAGCGGTGGTCTCGGTGGCCTTG CAGCTCGCCTCCTGCTACGGCCTCATTGCGGGGGCCATGGCCGC GGATGGATCTGTGCGTGTGCGTGGGGGAGGGGG	6982

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5	TGAGGCCGTAGCAGGAG	6983
	CTCCTGCTACGGCCTCA	6984
	Reduced linolenic acid omega-3 fatty acid desaturase <i>Triticum aestivum</i> Gln9Term CAG-TAG	6985
	CCTCCCCACGCACACGCACAGATCCATCCGCGGCCATGGCCCC CGCAATGAGGCCGGAGTAGGAGGCGAGCTGCAAGGCCACCGAG GACCACCGCTCCGAGTTCGACGCCGCCAAGCCGC	6986
10	GCGGCTTGCGGCGCTCGAACTCGGAGCGGTGGTCCTCGGTGGC CTTGACAGCTCGCCTCCTACTCCGGCCTCATTGCGGGGGCCATGG CCGCGGATGGATCTGTGCGTGTGCGTGGGGGAGG	6987
	GGCCGGAGTAGGAGGCG	6988
	CGCCTCCTACTCCGGCC	6989
	Reduced linolenic acid omega-3 fatty acid desaturase <i>Triticum aestivum</i> Glu10Term GAG-TAG	6990
15	CCCCACGCACACGCACAGATCCATCCGCGGCCATGGCCCCCGC AATGAGGCCGGAGCAGTAGGCGAGCTGCAAGGCCACCGAGGACC ACCGCTCCGAGTTCGACGCCGCCAAGCCGCCGC	6991
	GCGGCGGCTTGCGGCGCTCGAACTCGGAGCGGTGGTCCTCGGT GGCCTTGACAGCTCGCCTACTGCTCCGGCCTCATTGCGGGGGCCA TGGCCGCGGATGGATCTGTGCGTGTGCGTGGGGG	6992
	CGGAGCAGTAGGCGAGC	6993
	GCTCGCCTACTGCTCCG	6994
20	Reduced linolenic acid omega-3 fatty acid desaturase <i>Triticum aestivum</i> Cys13Term TGC-TGA	6995
	ACGCACAGATCCATCCGCGGCCATGGCCCCCGCAATGAGGCCGG AGCAGGAGGCGAGCTGAAAGGCCACCGAGGACCACCGCTCCGA GTTGACGCCGCCAAGCCGCCGCCCTTCCGCATC	6996
	GATGCGGAAGGGCGGCGGCTTGCGGCGTCTCGAACTCGGAGCGG TGGTCCTCGGTGGCCTTICAGCTCGCCTCCTGCTCCGGCCTCATT GCGGGGGCCATGGCCGCGGATGGATCTGTGCGT	6997
	GCGAGCTGAAAGGCCAC	6998
20	GTGGCCTTICAGCTCGC	6999
	Reduced linolenic acid omega-3 fatty acid desaturase <i>Oryza sativa</i> Ser4Term TCG-TAG	7000
	CTTCACAAATCACAAATCGGAATCAGATCCACCACGACACCCCGG CGGCAATGGCGGCGTAGGCGACCCAGGAGGCCGACTGCAAGGC TTCCGAGGACGCCCGTCTCTTCTCGACGCCGC	7001
	GCGGCGTCTGAAGAAGAGACGGGCGTCTCGGAAGCCTTGACGTC GGCCTCCTGGGTGCGCTACGCCGCCATTGCCGCCGGGGTGTGCT GGTGGATCTGATTCCGATTTGTGATTTGTGAAG	7002
	GGCGGCGTAGGCGACCC	7003
	GGGTGCGCTACGCCGCC	7004

Phenotype, Gene, Plant & Targeted Alteration	Altering Oligos	SEQ ID NO.
5 Reduced linolenic acid omega-3 fatty acid desaturase <i>Oryza sativa</i> Gln7Term CAG-TAG	ATCACAATCGGAATCAGATCCACCACGACACCCCGGCGGCAATG GCGGCGTCGGCGACCTAGGAGGCCGACTGCAAGGCTTCCGAGG ACGCCCGTCTCTTCTTCGACGCCGCCAAGCCCC	7001
	GGGGCTTGGCGGCGTCGAAGAAGAGACGGGCGTCCTCGGAAGC CTTGACAGTCGGCCTCCTAGGTCGCCGACGCCGCCATTGCCGCCG GGGTGTCGTGGTGGATCTGATTCCGATTTGTGAT	7002
	CGGCGACCTAGGAGGCC	7003
	GGCCTCCTAGGTCGCCG	7004
10 Reduced linolenic acid omega-3 fatty acid desaturase <i>Oryza sativa</i> Glu8Term GAG-TAG	ACAAATCGGAATCAGATCCACCACGACACCCCGGCGGCAATGGC GGCGTCGGCGACCCAGTAGGCCGACTGCAAGGCTTCCGAGGACG CCCGTCTCTTCTTCGACGCCGCCAAGCCCCCGC	7005
	GCGGGGGCTTGGCGGCGTCGAAGAAGAGACGGGCGTCCTCGGA AGCCTTGACAGTCGGCCTACTGGGTCGCCGACGCCGCCATTGCCG CCGGGGTGTCTGTGGTGGATCTGATTCCGATTTGT	7006
	CGACCCAGTAGGCCGAC	7007
	GTCGGCCTACTGGGTCG	7008
15 Reduced linolenic acid omega-3 fatty acid desaturase <i>Oryza sativa</i> Cys10Term TGC-TGA	TCAGATCCACCACGACACCCCGGCGGCAATGGCGGCGTCGGCGA CCCAGGAGGCCGACTGAAAGGCTTCCGAGGACGCCCGTCTCTTC TTCGACGCCGCCAAGCCCCCGCCCTTCCGCATC	7009
	GATGCGGAAGGGCGGGGGCTTGGCGGCGTCGAAGAAGAGACGG GCGTCCTCGGAAGCCTTTCAGTCGGCCTCCTGGGTCGCCGACGC CGCCATTGCCGCCGGGGTGTCTGTGGTGGATCTGA	7010
	GCCGACTGAAAGGCTTC	7011
	GAAGCCTTTCAGTCGGC	7012

WHAT IS CLAIMED IS:

1. An oligonucleotide for targeted alteration of genetic sequence, comprising a single-stranded oligonucleotide having a DNA domain, said DNA domain having at least one mismatch with respect to the genetic sequence to be altered, and further comprising chemical modifications of the oligonucleotide, said chemical modifications selected from the group consisting of an o-methyl modification, an LNA modification including LNA derivatives and analogs, two or more phosphorothioate linkages on a terminus, and a combination of any two or more of these modifications.
2. The oligonucleotide according to claim one that comprises two or more phosphorothioate linkages on at least the 3' terminus.
3. The oligonucleotide according to claim one that comprises a 2'-O-methyl analog.
4. The oligonucleotide according to claim one that comprises an LNA nucleotide, including an LNA derivative or analog.
5. The oligonucleotide according to claim one that comprises a combination of at least two modifications selected from the group of a phosphorothioate linkage, a 2'-O-methyl analog, a locked nucleotide analog and a ribonucleotide.
6. The oligonucleotide according to any one of claims 1 to 5 that comprises at least one unmodified ribonucleotide.
7. The oligonucleotide according to any one of claims 1 to 6, wherein the sequence of said oligonucleotide is selected from the group consisting of SEQ ID NOS: 4341-7012 .
8. A method of targeted alteration of genetic material, comprising combining the target genetic material with an oligonucleotide according to any one of claims 1 to 7 in the presence of purified proteins.

9. A method of targeted alteration of genetic material, comprising administering to a cell extract an oligonucleotide of any one of claims 1 to 7.

10. A method of targeted alteration of genetic material, comprising administering to a cell an oligonucleotide of any one of claims 1 to 7.

11. A method of targeted alteration of genetic sequence in callus, comprising administering to the callus an oligonucleotide of any one of claims 1 to 7.

12. A method of targeted alteration of genetic sequence, comprising combining target genetic material with an oligonucleotide according to any one of claims 1 to 7, said target genetic material being a non-transcribed DNA strand of a duplex DNA.

13. The genetic material obtained by any one of the methods of claim 8, 9 or claim 10.

14. A cell comprising the genetic material of claim 13.

15. A plant organism comprising the cell according to claim 14.

16. A plant or plant part produced by the method of claim 11.

17. A method of determining whether an oligonucleotide is optimized for targeted alteration of a genetic sequence, which comprises:

(a) comparing the efficiency of alteration of a targeted genetic sequence by an oligonucleotide of any one of claims 1 to 7 with the efficiency of alteration of the same targeted genetic sequence by a second oligonucleotide, said second oligonucleotide selected from the group of an oligonucleotide that lacks the mismatch, a fully modified phosphorothiolated oligonucleotide, a fully modified 2'-O-methylated oligonucleotide and a chimeric double-stranded double hairpin containing RNA and DNA nucleotides.

18. The method of claim 17 in which the alteration is produced in a plant cell extract.
19. The method of claim 17 in which the alteration is produced in a cell.
20. A kit comprising the oligonucleotide according to any one of claims 1 to 7 and a second oligonucleotide selected from the group of an oligonucleotide that lacks the mismatch, a fully modified phosphorothiolated oligonucleotide, a fully modified 2-O-methylated oligonucleotide and a chimeric double stranded double hairpin containing RNA and DNA nucleotides.

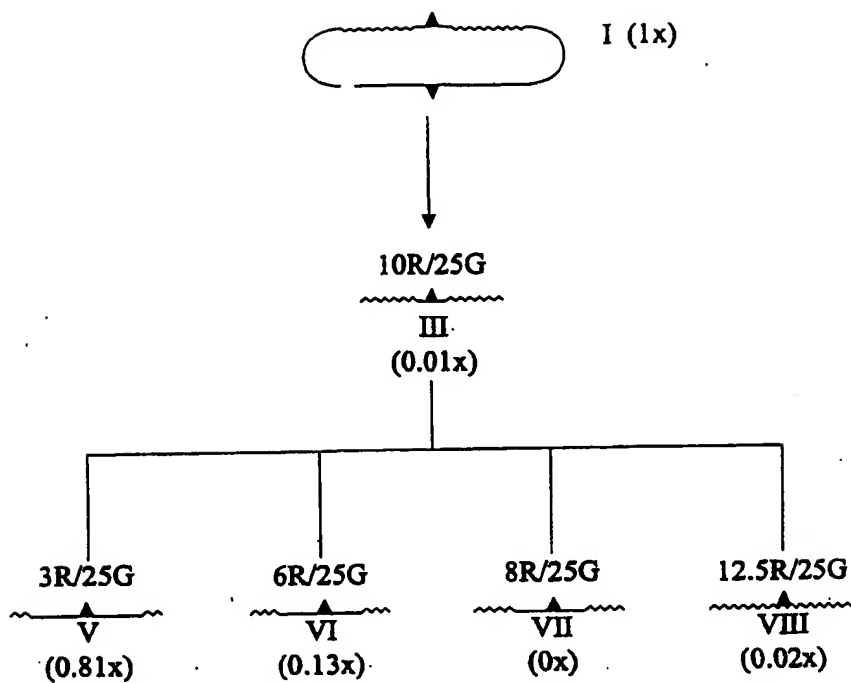


Figure 1A

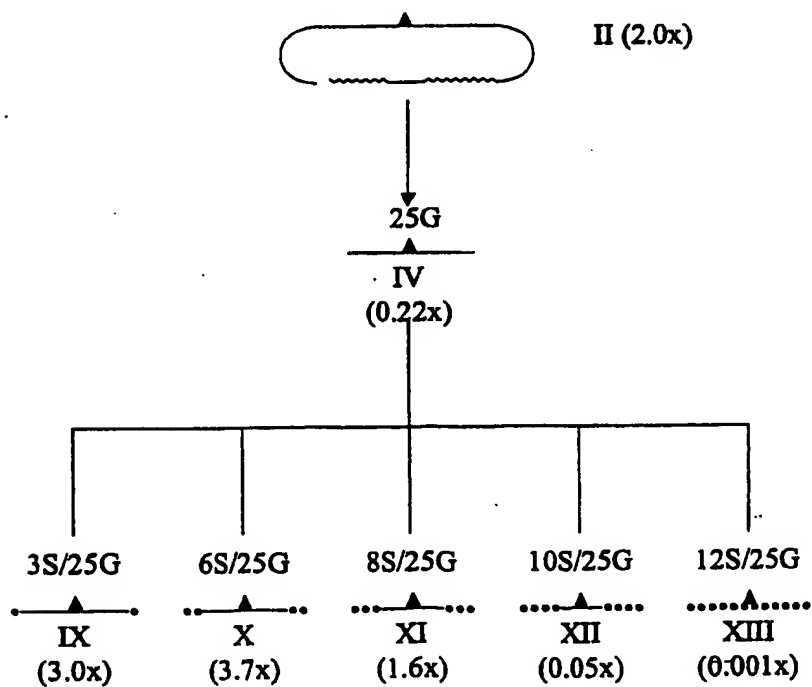


Figure 1B

Plasmids, DNA targets and chimeric oligonucleotides

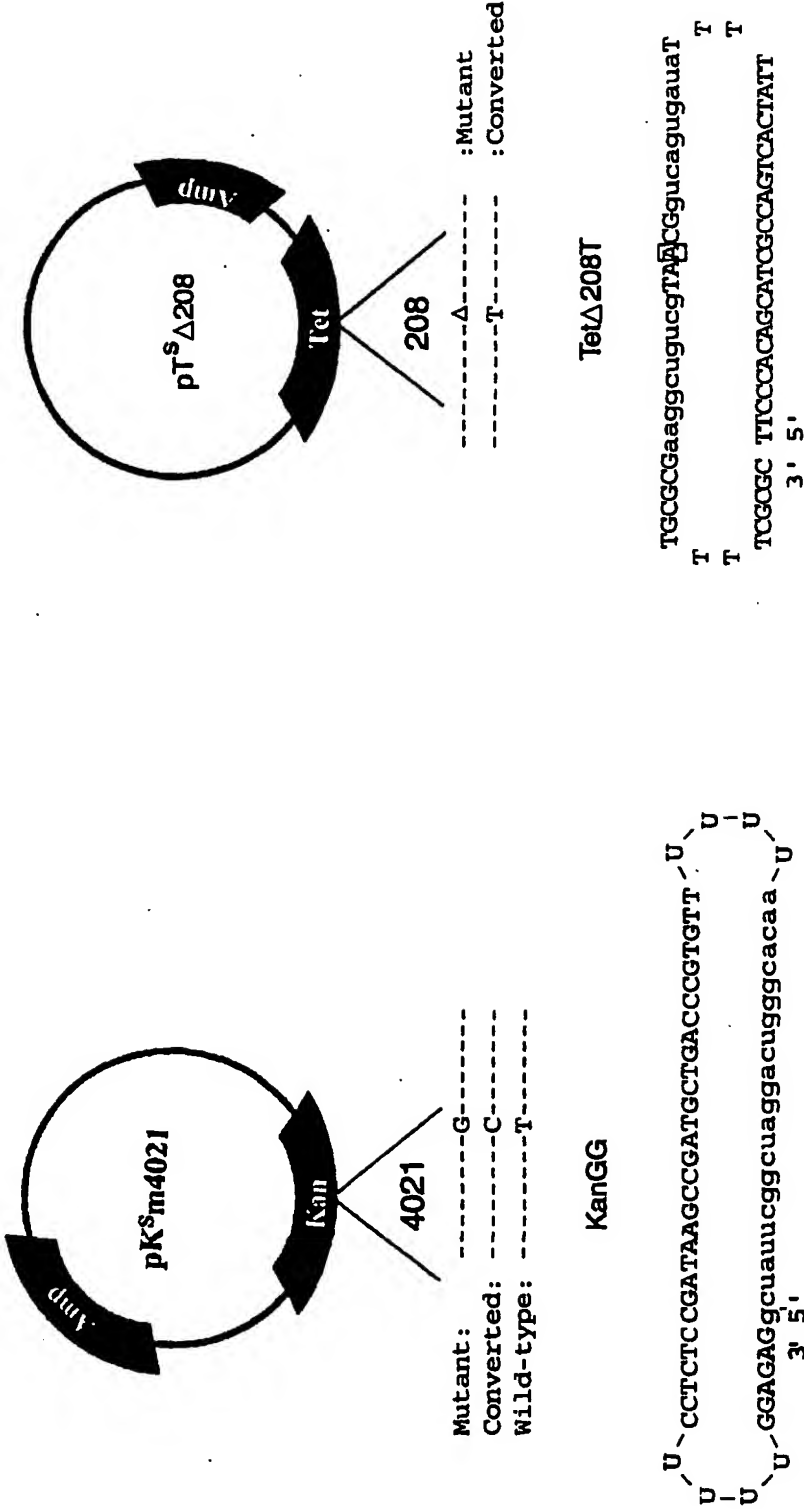
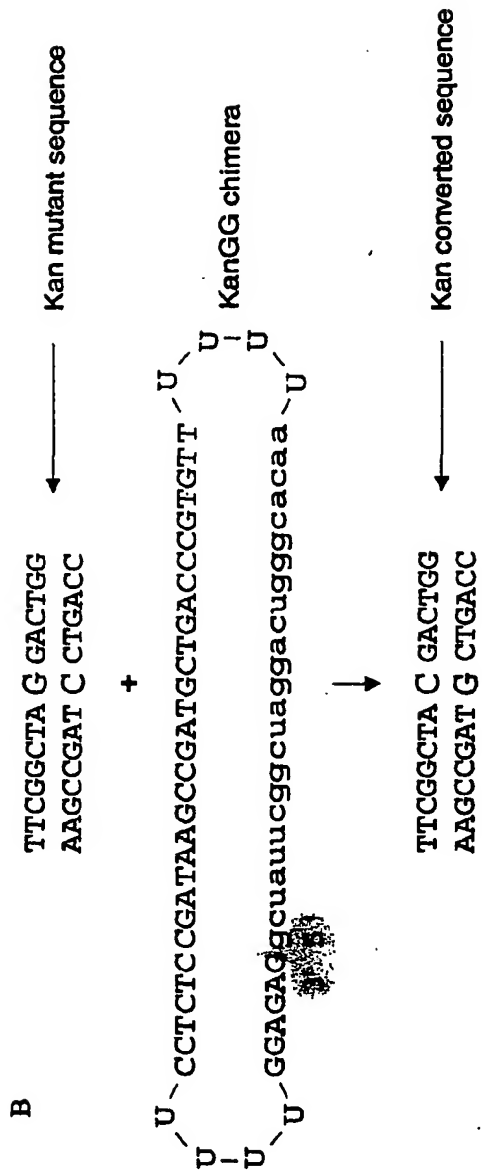


Figure 1C



DNA SEQUENCE ANALYSES

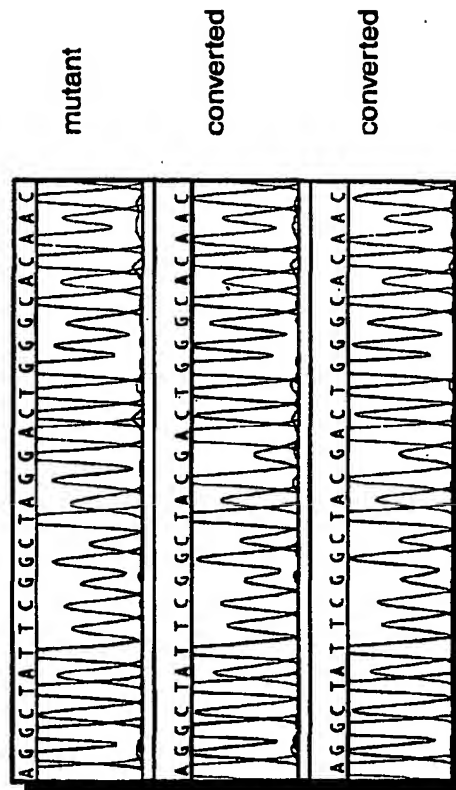


Figure 1D

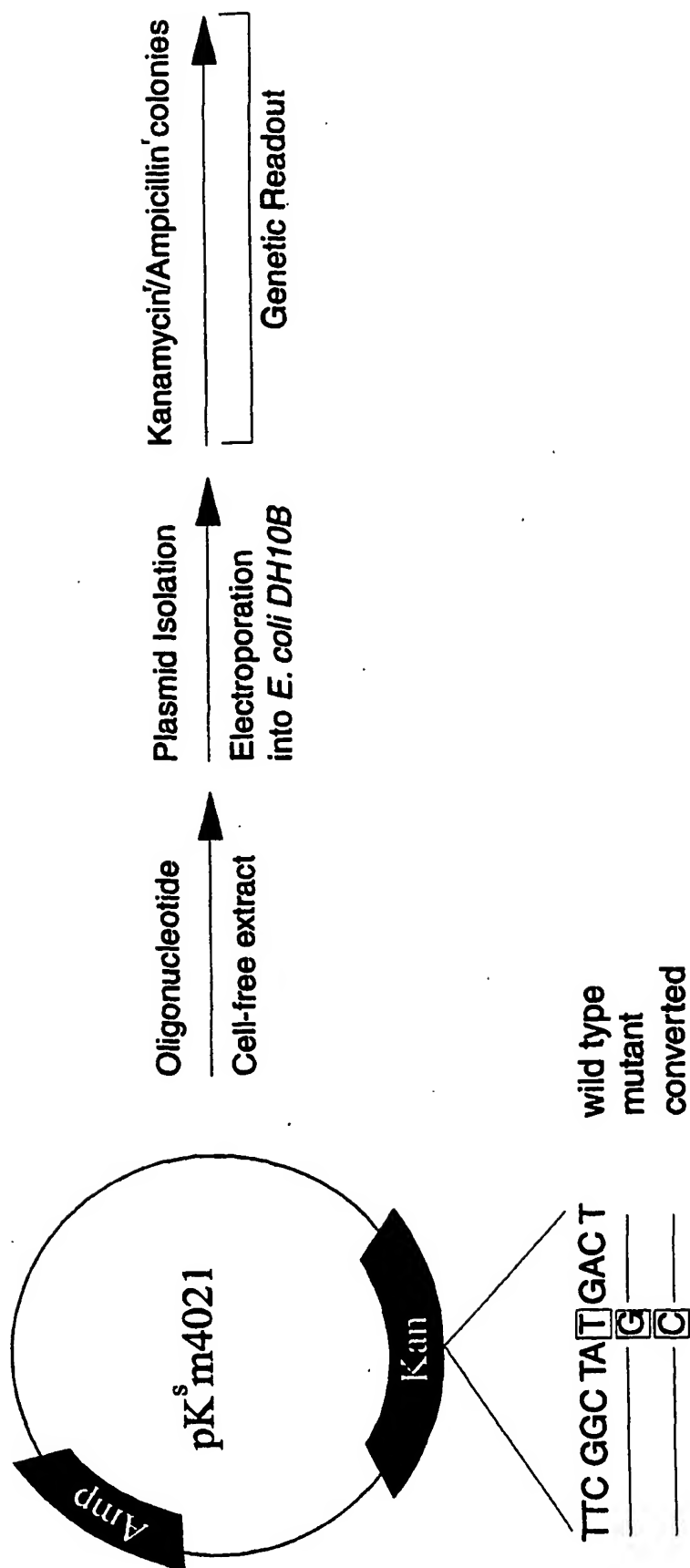
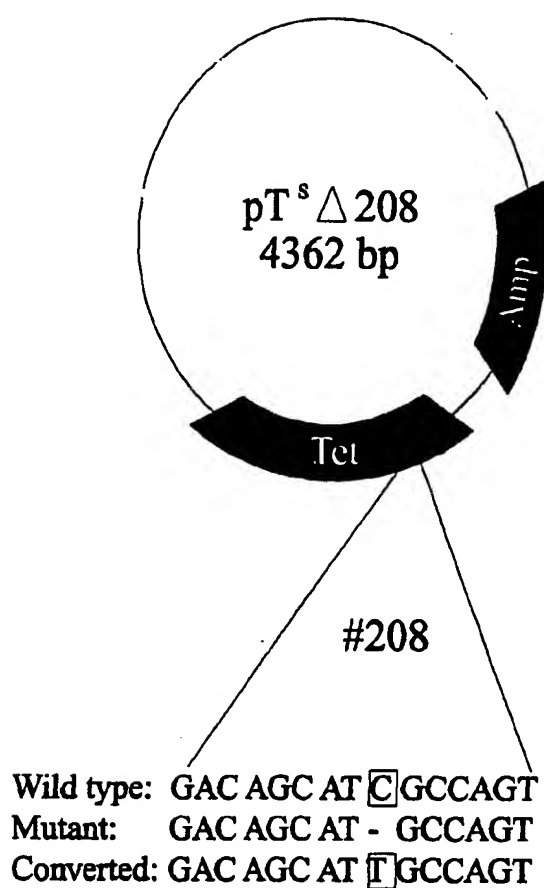


Figure 2



Sequence analysis of Tet^r plasmid Δ208

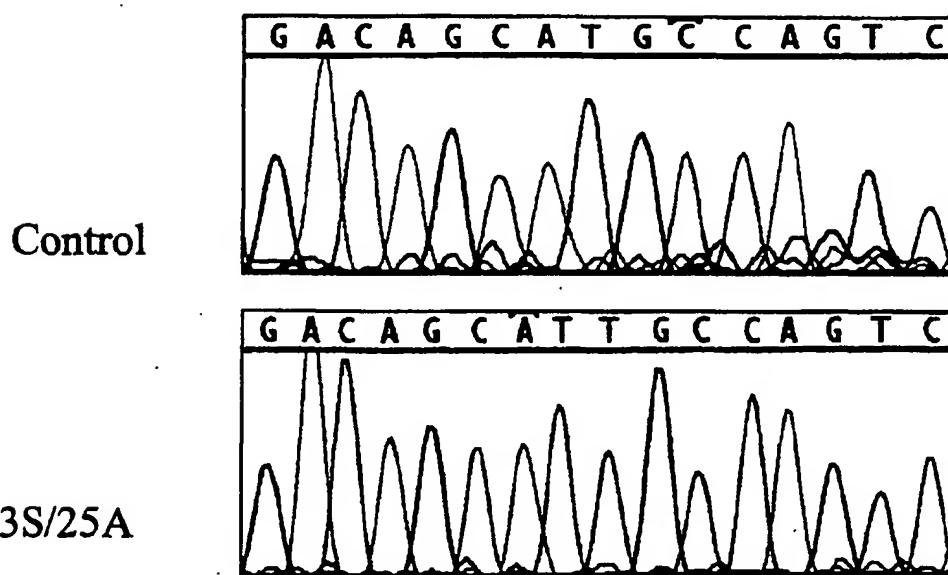


Figure 3

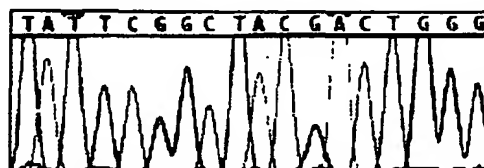
DNA sequence analysis of Kan^r plasmids

Target codon distribution					
oligomer	TAG	TAC	TAC/TAG	TGG	TCG
1) 3S/25G (20)	---	+	---	---	---
2) 6S/25G (20)	---	+	---	---	---
3) 8S/25G (20)	---	+	---	---	---
4) 10S/25G (18)	---	+	---	+(2)	+(2)
5) 25S/25G (4)	---	---	+(2)	+(2)	---

3S/25G



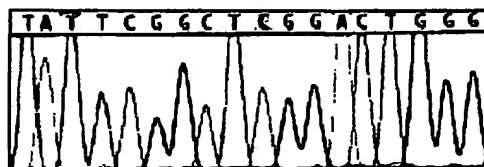
6S/25G



8S/25G



10S/25G



25S/25G



25S/25G



Figure 4

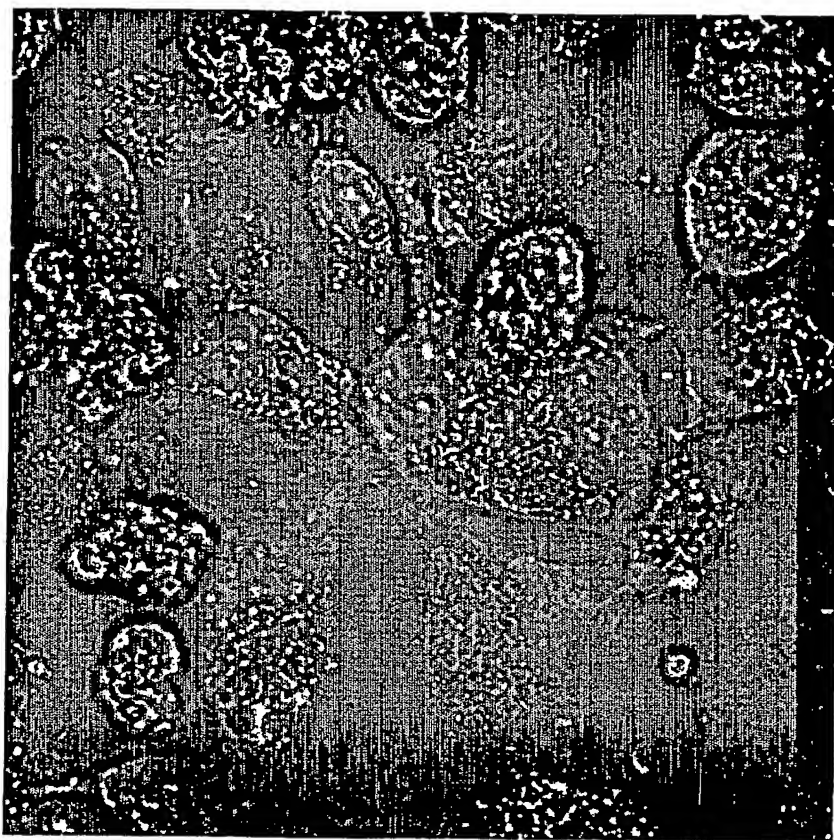


Figure 5

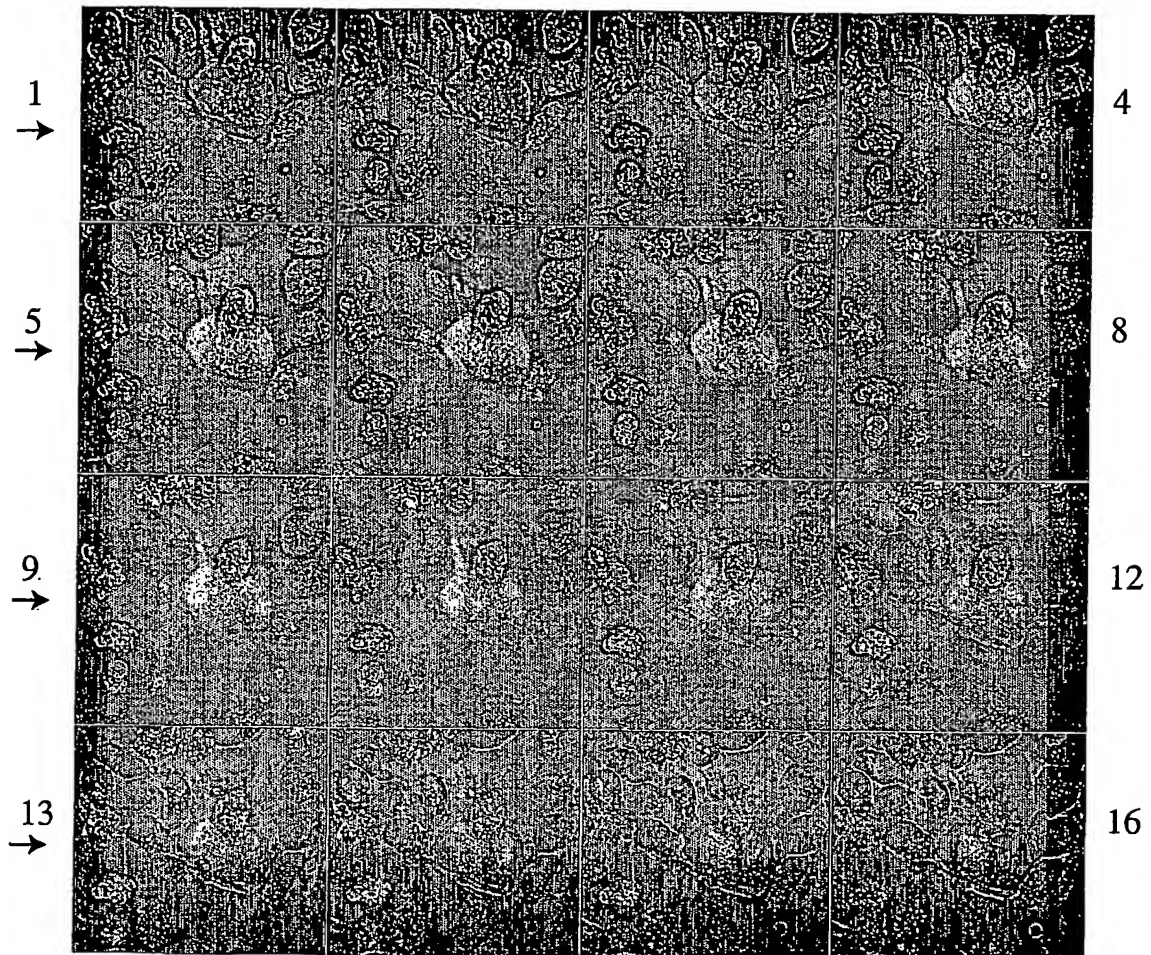
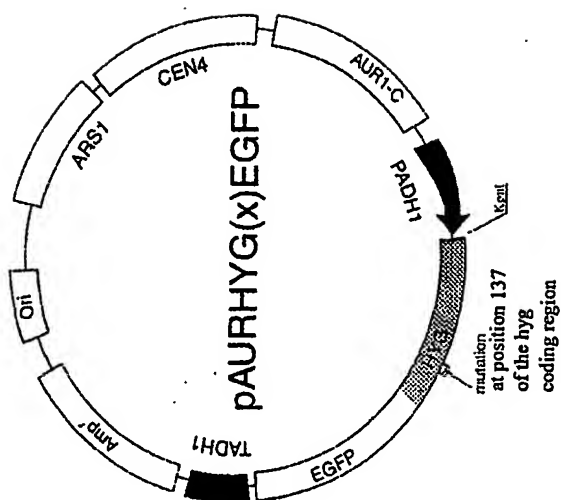


Figure 6

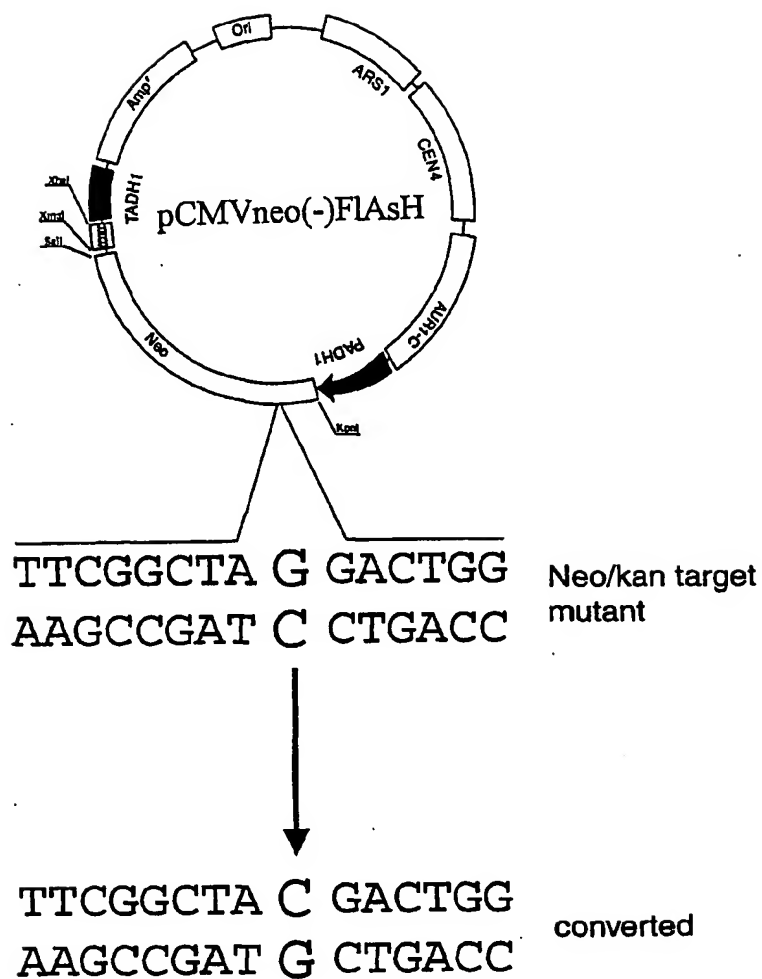
Sequence of normal allele: GTGGATATGTCCT
 Target/existing mutant: GTGGATAATGTCCT
 Desired alteration: GTGGATACGTCCT

Figure 7A



Sequence of normal allele: GTGGATATGTCCT
 Target/existing mutant: GTGGATAGGTCCT
 Desired alteration: GTGGATACGTCCT

Figure 7B



FUSION GENE FOR LIGAND BINDING

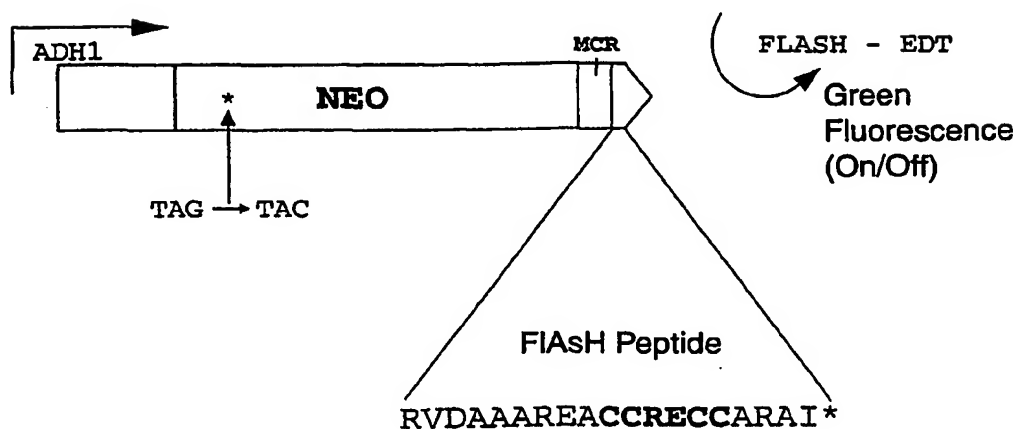


Figure 9

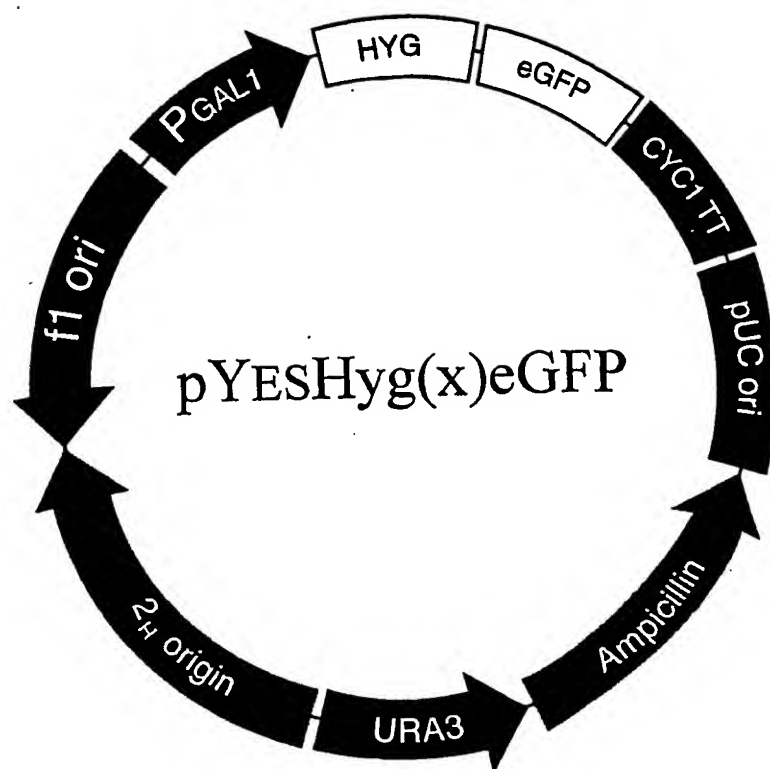


Figure 10

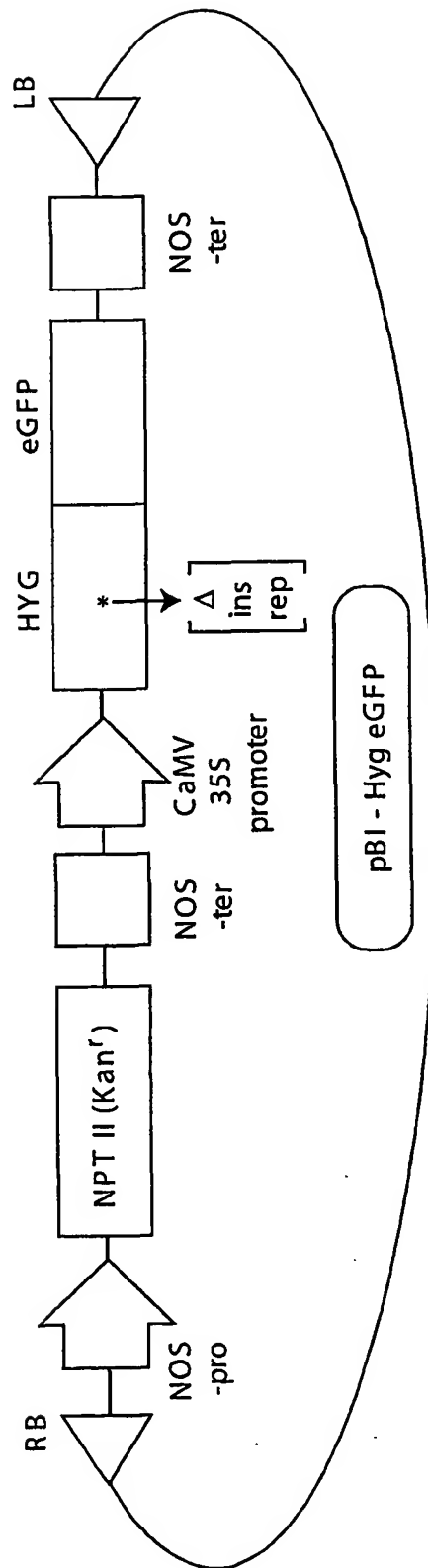


Figure 11